AUGUST 1959

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

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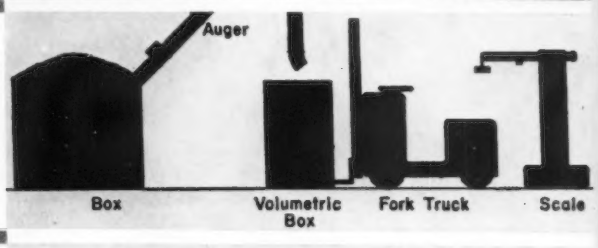

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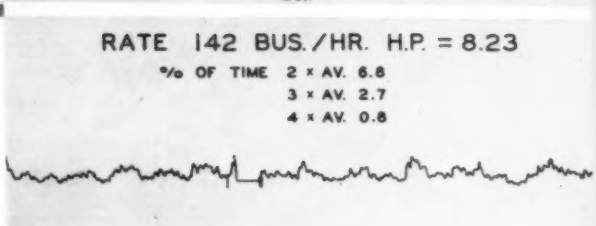

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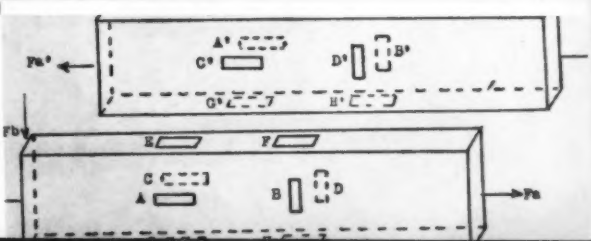

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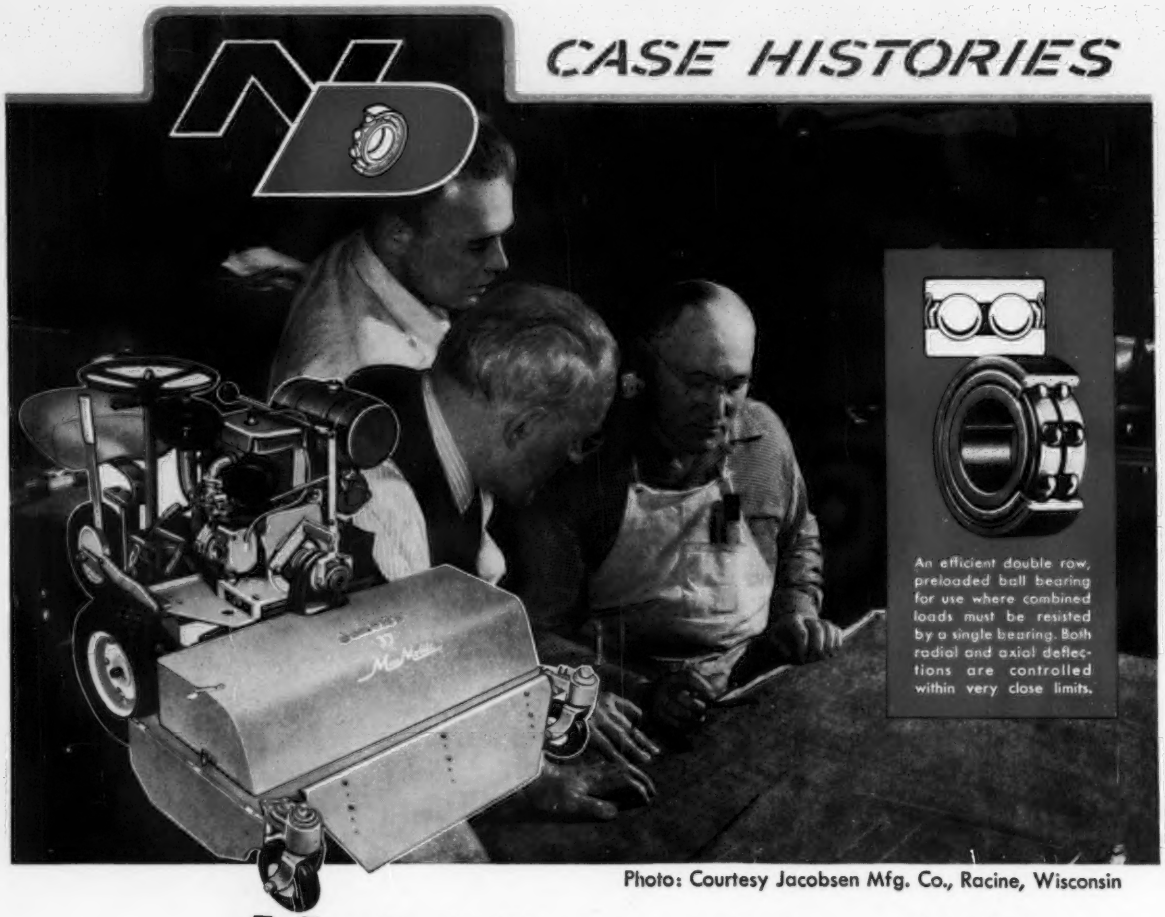

An efficient double row, preloaded ball bearing for use where combined loads must be resisted by a single bearing. Both radial and axial deflections are controlled within very close limits.

Photo: Courtesy Jacobsen Mfg. Co., Racine, Wisconsin

Ball Bearing Design Helps Cut Power Mower Costs $4.29 Per Unit!

CUSTOMER PROBLEM:

Require bearing design that will help reduce production costs of power mower without affecting mower's high quality and performance.

SOLUTION:

N/D Sales Engineer, working with company engineers, recommended a new, more efficient cutter housing design utilizing three precision New Departure production double row ball bearings. These high capacity dual purpose bearings resist heavy radial and thrust loads in any combination. The conversion accounted for a parts and assembly-time cost savings of $4.29 per mower. In addition, the manufacturer is able to promise mower users years of trouble-free performance, while pricing more competitively at retail!

Perhaps there's a New Department production ball bearing that will help lower costs and add new sales appeal to *your* product! Why not call on New Departure today? For more information write Department E-8.

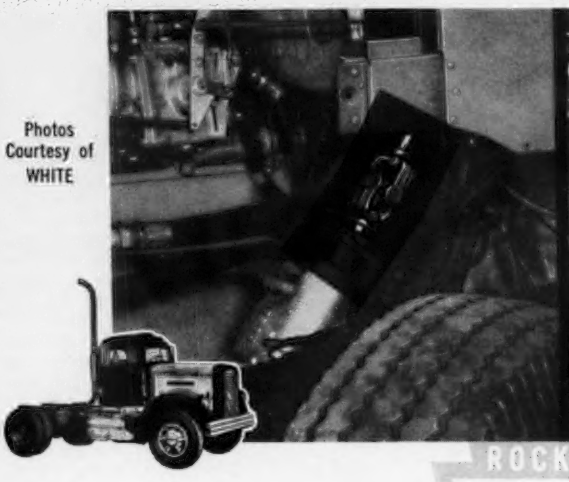
Replacement ball bearings available through United Motors System and its Independent Bearing Distributors

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

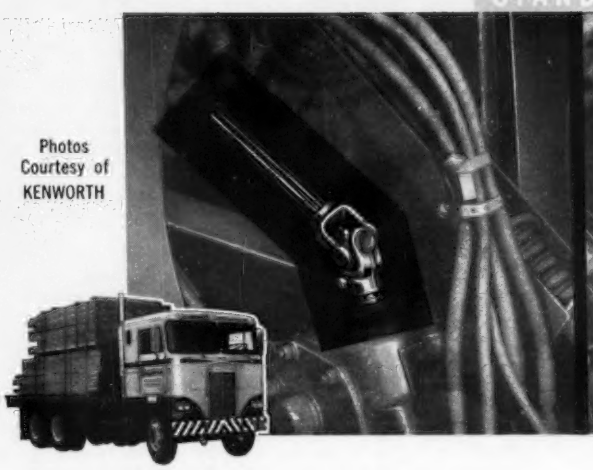
Photos Courtesy of WHITE



Photos Courtesy of GMC

To "take power around corners" steering rely on the Keystone of Quality...

Photos Courtesy of KENWORTH



Photos Courtesy of REO

...select BLOOD BROTHERS Jointed Steering Shafts

On power steering assemblies for famous-make trucks, Blood Brothers Universal Joints "take power around corners" smoothly and dependably. They're widely used on manual steering assemblies too . . . for road-building and construction machines, farm tractors and self-propelled implements.

When you need universal joints to "take power around corners" — or provide for drive shaft flexibility — be sure to consult Rockwell-Standard. Our engineers will gladly assist you . . . and their experience may save money on your project.

K-1C

L6S, L6N

ROCKWELL-STANDARD CORPORATION

Blood Brothers Universal Joints

ALLEGAN, MICHIGAN

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Agricultural Engineering

Established 1920

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New Public Relations and Advertising Manager

HARMON MULBAR, former advertising and market research manager of Redmond Co., Inc., Owosso, Mich., has been named to the position of public relations and advertising manager of the American Society of Agricultural Engineers to fill the vacancy created by the retirement of Raymond Olney at the end of June. The announcement followed selection of Mr. Mulbar by the Finance Committee and Council of ASAE shortly before the ASAE Annual Meeting in June. He assumed his duties August 3.

Harmon Mulbar

Mr. Mulbar brings to the position a background of experience in advertising and market research, in addition to professional training in business and economics. In his new assignment he will help to interpret to the public the practical significance of the Society's programs and activities and will support and coordinate the work of the Society's advertising representatives. He will make his headquarters at the Society office in St. Joseph.

A native son of Michigan, Harmon was born in 1924 at Jackson, attended grammar schools in Jackson, Detroit, Lansing, and Charlotte, and in 1942 graduated from East Lansing High School.

During 1942 and 1943 he was employed as a print clerk in the tool design department of Reo Motors in Lansing, Mich. He enlisted in the U.S. Navy in 1943 and attended its signalman school for visual communications. He served aboard the U.S.S. Borum (destroyer escort) in the Atlantic, and participated in D-Day at Normandy. In 1946, he was honorably discharged as a petty officer second class.

During 1948 to 1951, he was employed by Marlin-Rockwell Corp. as a laboratory technician in Jamestown, N. Y.

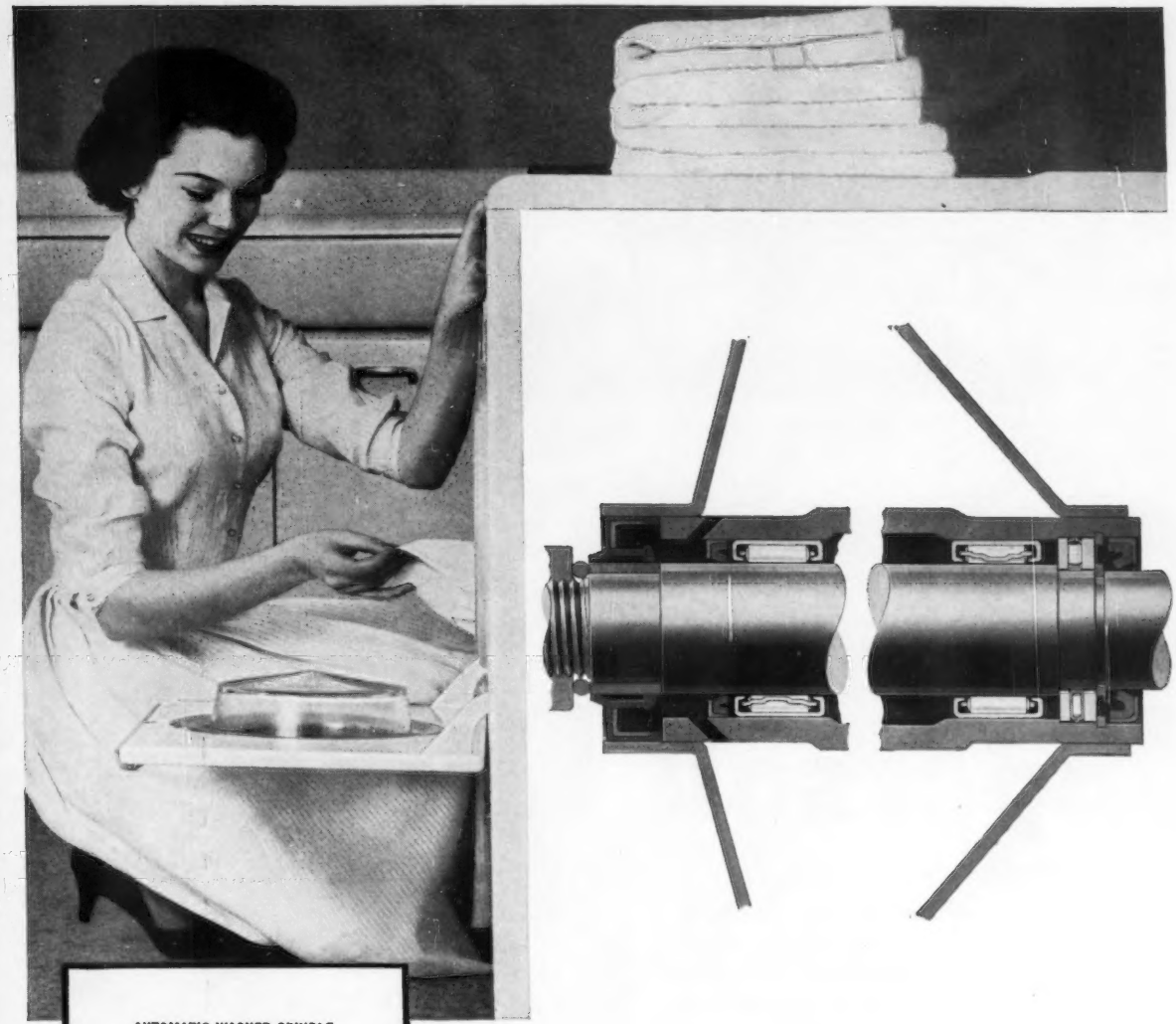
He spent one year at Michigan State University before he enrolled at Alma College, Michigan, where he majored in economics and business administration. In 1954 he earned a B.A. degree.

After graduation and until 1955, he managed a service station in Alma, Mich., and in 1956 was connected with Sears, Roebuck & Co., Lansing, Mich. as a sales trainee. He has been advertising and market research manager of the Redmond Company, since 1956. In this capacity he supervised the advertising and market research activities of the company and acted as secretary to the product development planning committee. Preparing catalogs, product description sheets, handbooks, and sales promotion items were also among his responsibilities. He wrote articles on company products, servicing methods, manufacturing processes, and a company history. Other responsibilities included the conducting and preparing of market surveys, and monthly and yearly sales analyses.

Included in Mr. Mulbar's outside interests are reading, gardening, and sports.

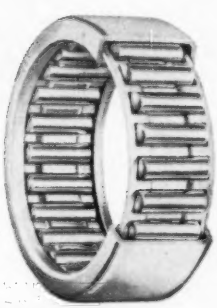
He married Cherilene Minot of Newago, Mich., in 1948, and they have two daughters, Leah, six, and Nancy, three years of age.

His mother resides in Honolulu, Hawaii, where she is secretary-treasurer and part owner of Menehune-Mac, Ltd., manufacturer of fancy candy products. His father, Harold, deceased, enjoyed national recognition as a Polygraph (lie detector) expert and detective. The elder Mulbar was captain and chief of detectives, Michigan State Police, and was selected by General MacArthur to become chief of the Public Safety Division for the Allied Powers in Japan.



AUTOMATIC WASHER SPINDLE

Is equipped with two Torrington Drawn Cup Roller Bearings for operating stability and long pregreased life. Spindle thrust is handled by one compact Torrington Needle Thrust Bearing.



New Low-Cost Bearing Advances Design and Performance of Home Appliances!

The new Torrington Drawn Cup Roller Bearing opens new possibilities for improved design and performance of washing machines and other major appliances.

For the first time, the advantages of drawn cup outer race construction are available in a precision, compact and low-cost roller bearing. This construction permits exceptional compactness, simple housing design and easy installation by press fit. Highly efficient roller guidance and ample provision for lubricant storage insure smooth starting, cool running and extended service life, especially where high-speed operation and long pregreased life are required.

Today's designer now can secure the advantages of efficient anti-friction performance at low cost in an exceptionally lightweight, compact design with the new Torrington Drawn Cup Roller Bearing. For engineering assistance, call on your Torrington representative. And write for the new bulletin, "Torrington Drawn Cup Roller Bearings." **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • THRUST • BALL • NEEDLE ROLLERS

The all-new Minneapolis-Moline WC 15' disc plow equipped with famous Ingersoll discs.

Ingersoll Discs

Farmers can always count on a big day's work from implements equipped with sharp, husky Ingersoll discs. Like this new Minneapolis-Moline disc plow, for example. Mounting 24 keen-edged Ingersoll discs, it turns the earth in time-saving style—cuts big fields down to easy-does-it size.

Ingersoll discs make any disc plow or harrow work better. And they take the beating of rough field use without cracking, curling or warping. That's because they're made of *cross-rolled* TEM-CROSS® steel—a special, super-tough steel that gives Ingersoll discs unequaled strength and impact resistance.

That tells you why all major implement manufacturers use Ingersoll discs as original equipment—and why it pays to ask for the same high quality when you need disc replacements.

The new Minneapolis-Moline KA disc harrow mounts 40 Ingersoll discs.

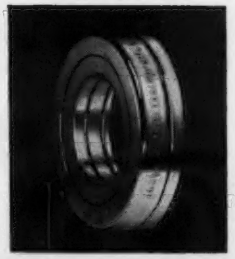
INGERSOLL PRODUCTS DIVISION
Borg-Warner Corporation • Chicago 43, Ill.
WORLD'S LARGEST MANUFACTURER OF DISCS

B-W

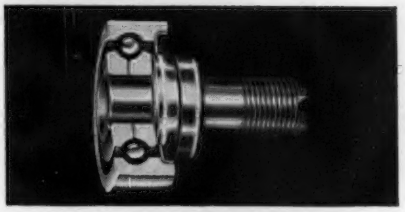
Export Sales: Borg-Warner International, 36 S. Wabash, Chicago 3

1884 75 YEARS 1959

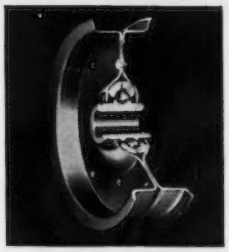
THE ONLY MANUFACTURER OF DURA-DISC—THE STEEL THAT IS THE ECONOMICAL REPLACEMENT FOR HIGH COST ALLOYS



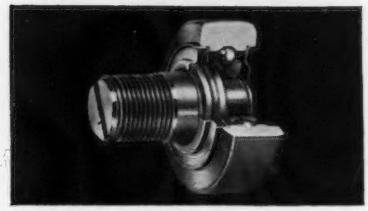
Clutch Bearings



Hay Rake Bearings



Idler Pulley Assemblies



Plunger Rollers

PIONEERING EXPERIENCE PAYS OFF FOR YOU . . . WHEN YOU USE BALL BEARING "PACKAGE UNITS" FROM BCA

You simplify production line installation and reduce manufacturing costs with "package units" designed and produced by BCA—the company that conceived and developed the ball bearing "package unit" idea. Bearing, housing and seal are combined in one rugged unit lubricated for life and sealed against water, dust and grit. BCA "package units" are available for a very wide range of applications including hay rake bearings, idler pulley assemblies, clutch bearings and plunger rollers. Count on BCA experience to provide ball bearing "package units" that are right for you and your customers . . . whether the application is unusual or routine. Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

BCA BALL BEARINGS

BEARINGS COMPANY OF AMERICA
DIVISION OF
Federal-Mogul-Bower Bearings, Inc.

Report to Readers . . .

REMOVING STONES FROM FIELDS MAY INCREASE SOIL EROSION

To facilitate machine harvesting of potatoes and reduce wear and tear on machines operating in stony fields typical of northeast US, the natural solution would appear to be removal of the stones from the fields. However, this idea has a flaw: it may increase soil erosion. . . . . According to a study made by a USDA soil scientist and a Maine AES agronomist, it was found that removing stones larger than 1/2 inch reduces soil pore space and water infiltration, which increases runoff with soil loss nearly proportional. Soils common to the Maine potato-growing area contain coarse materials – particularly on slopes – and acquire in winter a pavement-like rock surface, which decreases erosion. This rock mulch disperses the energy of raindrops and decreases soil surface sealing, thereby increasing water infiltration.

LEVEL IRRIGATION PROVIDES MORE EFFICIENT WATER USE AND CONTROL

Leveling of land for irrigation, developed by USDA agricultural engineers, is giving farmers of the US Southwest more efficient use and control of water. The method includes leveling the land to be irrigated and enclosing it in low ridges to confine either rainfall or irrigation water. . . . . Any rainfall is held on this land until stored or evaporated, and irrigation water distributes evenly and percolates to a uniform depth without adding water to the water table. The result is uniform germination of seed and plant population – and greater production. . . . . The system has proved to be highly efficient, since up to 90 percent of the water applied is used, as contrasted with runoff and erosion losses of as high as 70 percent in the case of graded irrigation. . . . . Level irrigation also facilitates leaching for salinity control, since water remains uniformly on the land until it soaks in or evaporates. The system also requires less labor, since with underground pipes the only labor involved is opening and closing the valves.

RESEARCH RESULTS FAVOR ENSILING OF HIGH-MOISTURE SHELLED CORN

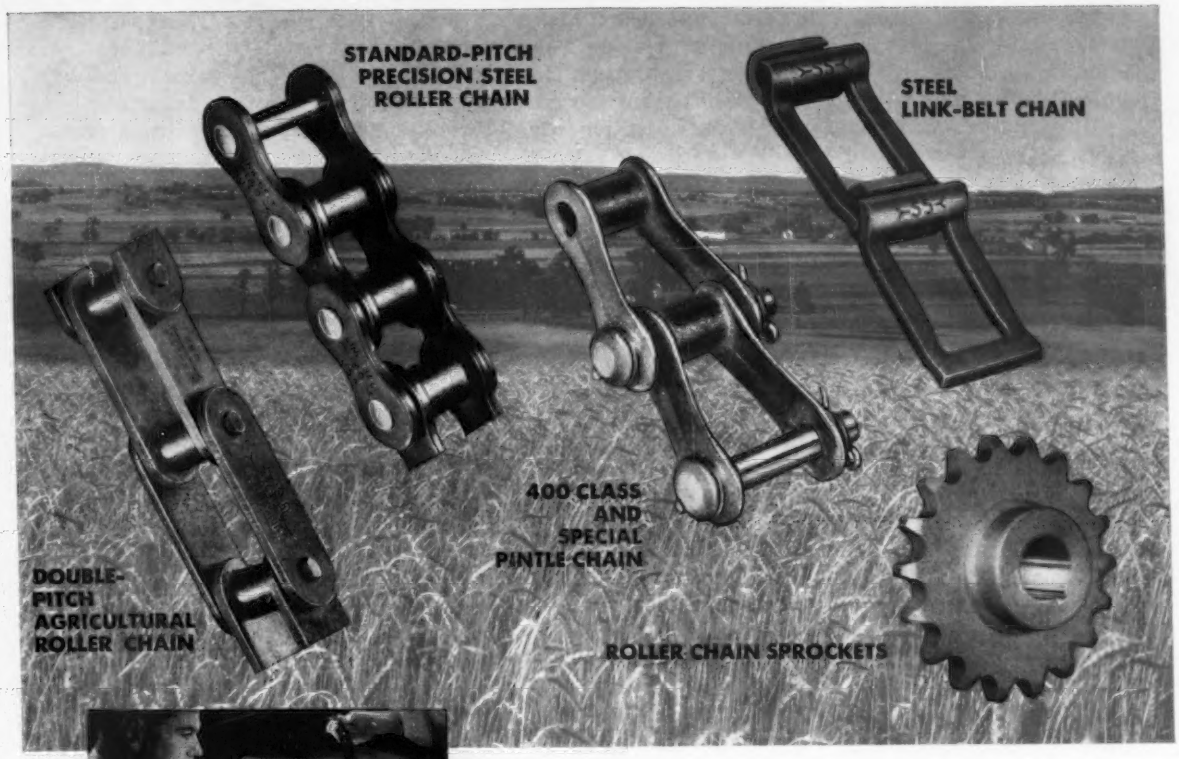
A team of researchers at the Illinois AES, including agricultural engineers and animal and dairy scientists, state that a year's cooperative study indicates that high-moisture corn, after storage in conventional, upright silos, about equals dry corn in feeding value. The particular advantage of the practice is that it increases the ease of handling corn. Farmers are eagerly adopting the practice for these reasons: they can harvest earlier and faster; a minimum of operations and equipment is required; storage costs are comparatively low; the stored corn is rodent-free, and it simplifies feeding out the crop mechanically. The researchers recommend that high-moisture shelled corn to be stored in silos should be harvested as close to 30 percent moisture as possible.

MACHINE HARVESTING OF POTATOES RESULTS IN LESS TUBER INJURY

A field study by a California AES research team – an agricultural engineer and a vegetable crops specialist – showed less injury to the same variety of potatoes when machine harvested than when harvested by hand. In the case of the latter method, the injury increased considerably between the field and place of storage. . . . . The purpose of the study was to observe the operational efficiency of the machines and to compare the amount of damage to potatoes by mechanical and hand harvesting. Six two-row, direct-harvesting-type machines of the same make were used, digging and loading in one operation. Each harvester was pulled by a 40-45-hp track-type tractor, but had its own engine to operate the harvester mechanism. Each machine harvested about 2/3 to 3/4 acre per hour. While not conclusive, the over-all results from this study indicate promising possibilities for practically complete mechanization of potato harvesting.

(Continued on page 432)

How LINK-BELT'S broad chain selection aids the designer, improves the design


STANDARD-PITCH PRECISION STEEL ROLLER CHAIN
STEEL LINK-BELT CHAIN
400 CLASS AND SPECIAL PINTLE CHAIN
DOUBLE-PITCH AGRICULTURAL ROLLER CHAIN
ROLLER CHAIN SPROCKETS

EXPERT ENGINEERING—Link-Belt maintains an engineering staff of unsurpassed experience in the application of chain.

ACCURATE MANUFACTURE — Modern, specialized machines give economies of large-scale mass production, yet maintain high accuracy.

A COMPLETE LINE assures correct selection for each job. This Case No. 135 manure spreader uses Link-Belt steel detachable chains on apron conveyor.

LINK-BELT builds a complete line of chains, chain attachments and sprockets . . . to top farm machine standards, to match your needs

With Link-Belt's broad line of chains and chain attachments, designers of farm machinery are sure to get the *one* chain that's best for each application. Horsepower, loading, speed, impact—every requirement can be met to enable your machine to maintain rated performance and efficiency.

Yes, Link-Belt's unmatched facilities, services and experience (over 300 farm machinery manufacturers rely on Link-Belt) are your best assurance of quality products, properly applied. Next time you're considering a drive or conveyor application, our specialists will be glad to work with you. For facts and prompt service, call your nearby Link-Belt office or write our Indianapolis plant at 220 S. Belmont Ave.

640-Page Catalog 1050 has complete information on all Link-Belt chains. Other Link-Belt components for power transmission and materials handling are also detailed. Write for your copy.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,189

. . . Report to Readers (Continued from page 430)

NEW SOIL PENETROMETER MEASURES THE VARIATIONS IN DEGREE OF COMPACTION

A California AES olericulturist has developed a new inexpensive, easy-to-use soil penetrometer that measures variations in degree of compaction. The instrument consists of a 3/8-inch polished, stainless-steel rod 4 feet long, to which a stop 2½ feet from the bottom end is welded. A 6-pound cylindrical weight with a 1/2-inch hole is slipped over the upper end of the rod. A second stop with a setscrew is placed on the rod, so the dropping height can be varied up to 1½ feet. The point is sharpened to a 45-degree angle . . . . Results of field studies made with this penetrometer indicate that, under a given set of soil conditions, it can be used to measure traffic-induced compaction. The penetrometer is relatively easy to use, and no costly equipment is required. While variations in individual readings is considerable, the instrument will measure variations in degree of compaction. Though a large number of readings need to be made for statistically valid data, they are relatively easy to obtain.

NEW STICKER SOLUTION INCREASES THE RETENTION QUALITIES OF PESTICIDES

A solution of two or more water-soluble resins in methanol has been found to greatly increase the retention qualities of ordinary insecticide water-spray mixtures. When used with water sprays, it leaves the insecticide firmly attached to leaves, fruit, and other vegetation after the water has evaporated. The initial loss of pesticide during spraying, along with later loss due to weathering, is therefore greatly reduced, according to entomologists at the Delaware AES where extensive tests have been conducted. . . . . In addition to its good covering and sticking power, it is compatible with other materials used in agricultural sprays, has longer shelf life, mixes easily without diluting or premixing, doesn't clog nozzles, is not toxic to animals or plants, and is economical since only 1 quart is needed for each 100 gallons of water.

LIGHT-WEIGHT, FARM-TYPE REFRIGERATED EGG CABINET

What may well prove an attractive item for both egg producers and prefabricators of farm structures is a light-weight, paneled, refrigerated egg cabinet designed by agricultural engineers of the University of Massachusetts. The panels used for making this cabinet have 3-inch expanded polystyrene cores, 0.025-inch aluminum faces, and are joined by means of specially extruded aluminum and plastic sections. Operationally the cabinet is said to have adequate resistance to heat flow and high resistance to vapor absorption and transmission. Its cost is estimated at well under that for present types of site-built egg rooms and cabinets. The cabinet is specially adapted for convenience in shipping. Total weight of panels, including doors, for a 7x10x7-foot-high cabinet with capacity for 32 cases of cooled eggs, plus 8 to 10 cases in precooling baskets, is approximately 350 pounds. Required shipping space minus packing materials, is about 88 cubic feet. . . . The cabinet is also adapted to fruit and vegetable cooling and storage, especially if such products are to move directly from producer to consumer.

NEW SOLDER DEVELOPED FOR USE ON STAINLESS STEEL DAIRY EQUIPMENT

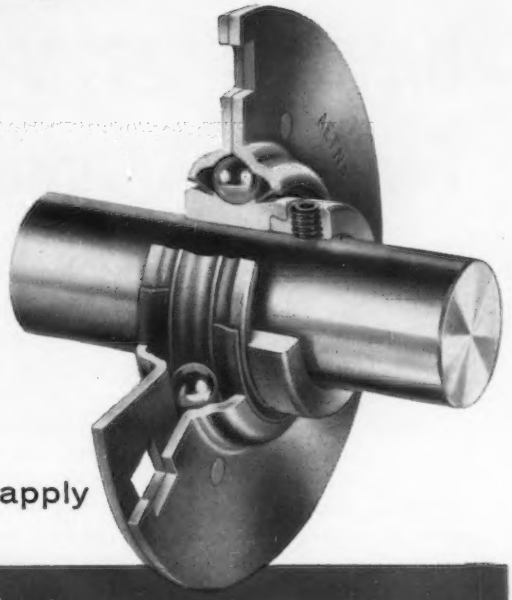
Agricultural engineers at the University of Minnesota are advising farmers not to trade in stainless steel milker buckets merely because the soldering has broken loose on handles or other fittings. Repairs can be made easily by using one of the new dairy solders containing no harmful lead or antimony. . . . . This solder was specially developed for stainless steel used around the milkhouse and is suitable for repairing equipment for grade A milk production. This new product is now on the market and is easy to use. All that is needed for its use is the solder itself, a special cleaning flux that goes with it, and a small torch – propane-air, acetylene-air, or oxy-acetylene. There is actually no need for a soldering iron or copper. It produces a strong bond that stays bright and will not tarnish or produce off-flavors.

NOW... more manufacturers can afford to put more ball bearing efficiency to work in more places

Aetna

ADAPTER BEARING

Economical to buy . . . economical to apply

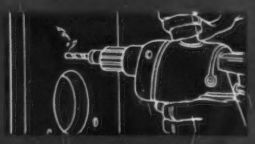


Equipment manufacturers who must stretch bearing dollars in order to build to a price need look no further than this Aetna Adapter bearing —the completely *PACKAGED* ball bearing unit that brings low-cost, anti-friction efficiency within the range of all light-duty slow-speed equipment.

Designed and built-to-be-installed-and-forgotten, this permanently lubricated, sealed-for-life Adapter bearing requires no re-lubrication, no maintenance of any kind. It combines self-aligning bearing, seals, mounting flange and locking collar in a single, compact, factory-assembled *PACKAGE* that mounts easily, quickly, wherever shafts can be supported, including mounting on sheet metal or any semi-rigid structural member. Available in 8 standard shaft sizes, ½" to 1¼". Send for catalog AG-57 or call in the local Aetna representative listed in the yellow pages. Aetna Ball & Roller Bearing Co., Division of Parkersburg-Aetna Corp., 4600 Schubert Ave., Chicago 39, Ill.

EASY, QUICK 3-STEP MOUNTING

1



Drill (or punch) 3 bolt holes in shaft supporting member.

2

Place Adapter bearing in position, insert bolts and tighten nuts.

3

Install shaft, twist locking collar, tighten set screw.

Aetna

ANTI-FRICTION CONSULTANT TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

DAYTON BSI* V-BELTS Are Tailor Made For Back-Breaking Fixed-Center Drives

Here's an everyday problem in designing agricultural equipment . . . fixed-center drives. It's a back-breaking situation for ordinary V-Belts, yet there's no simpler way to maintain tension than the use of a back-side idler.

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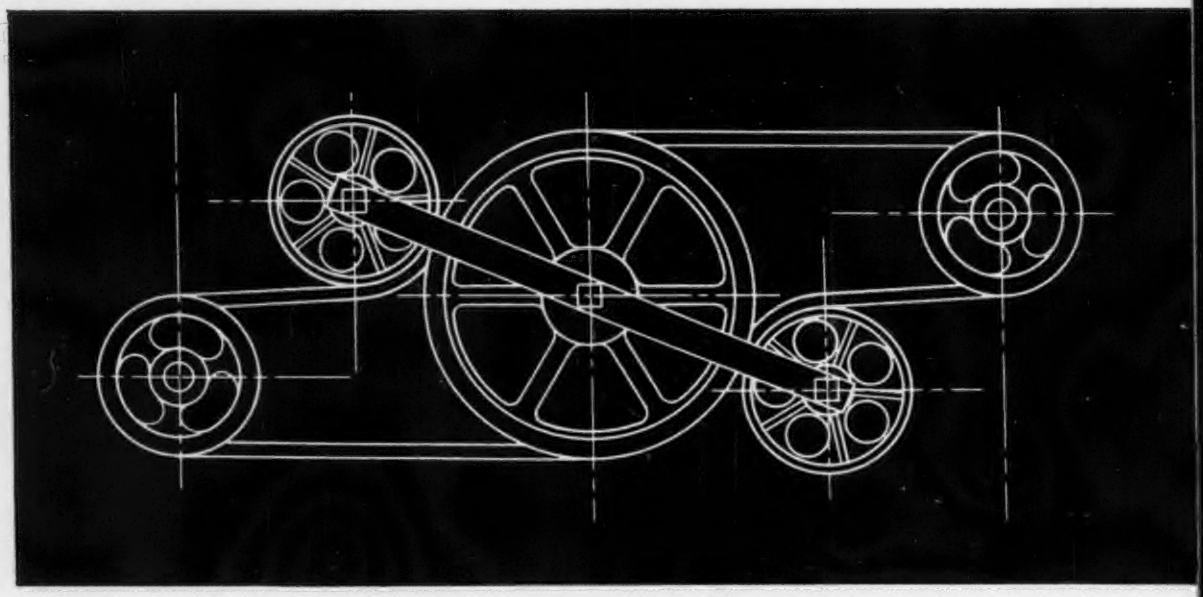
Quite a quandary . . . until Dayton developed a Back-Side Idler V-Belt as the perfect answer for the fixed-center drive. The BSI* V-Belt is just one of the many V-Belts developed by Dayton to do a special job in Agricultural applications.

Specifically designed to withstand the stresses of both compression and tension, Dayton's BSI* V-Belt sustains constant two-way flexing without building up excessive heat.

In a special added-strength construction, Dayton employs high-tenacity cords which are Thoro-bonded and straight laid across the belt for smooth, even pulling power.

Here, then, is a V-Belt especially designed for maximum endurance in back-breaking, fixed-center drives . . . the Dayton Back-Side Idler V-Belt. You'll want it specified wherever back-side idlers are used . . . to insure trouble-free service for the life of your design.

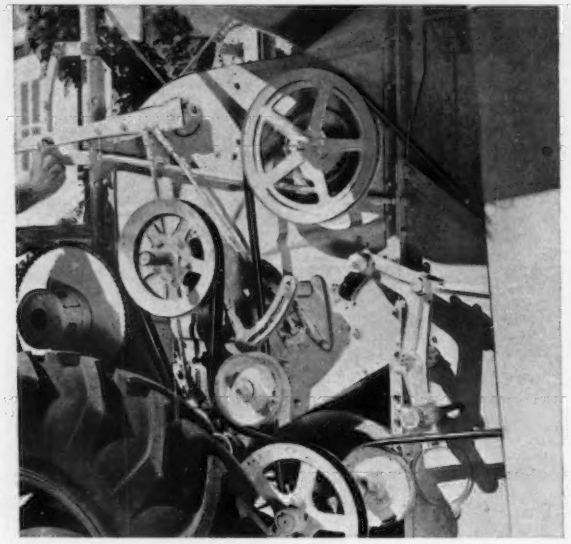
*Back-Side Idler



Dayton Industrial

Melrose Park, Ill.

Agricultural Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Melrose Pa



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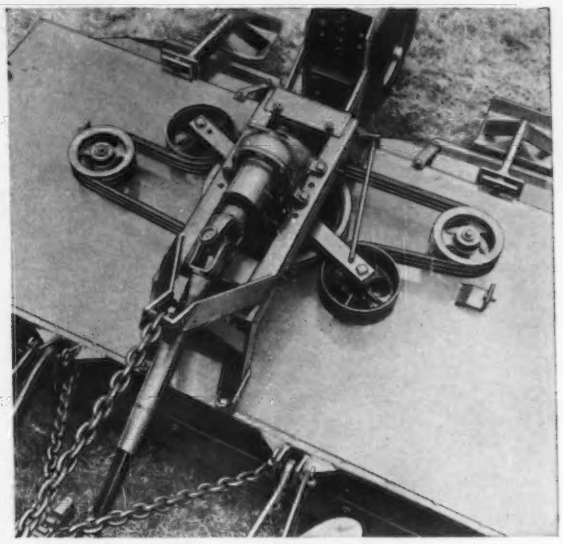
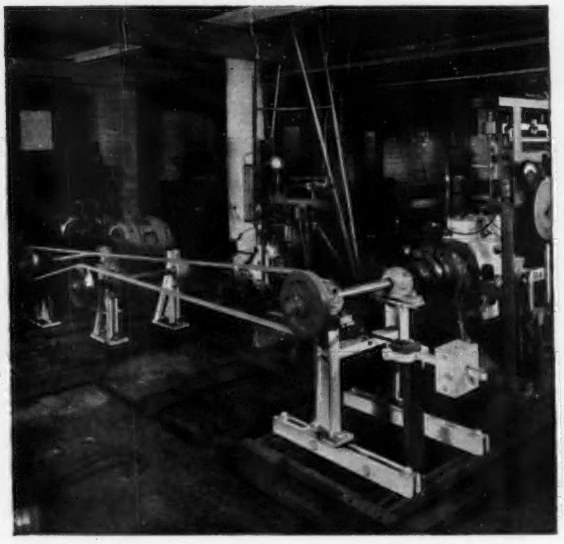
This is an ordinary back-side idler drive except for the fact that it's coupled directly to the engine crankshaft. Actually, all the power to every accessory drive flows through this one high-capacity Dayton BSI V-Belt.



Tandem Fixed Center Drive

In this design, two mover blades are driven from a single power source by a set of dependable Dayton BSI V-Belts. Constant tension is maintained by a parallel set of back-side idlers . . . to make one drive perform the work of two.



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For more information on the BSI V-Belt, or on any of Dayton's V-Belts for Agriculture, write, wire, or call the Dayton Agricultural OEM Division, 2001 Janice Ave., Melrose Park, Ill.

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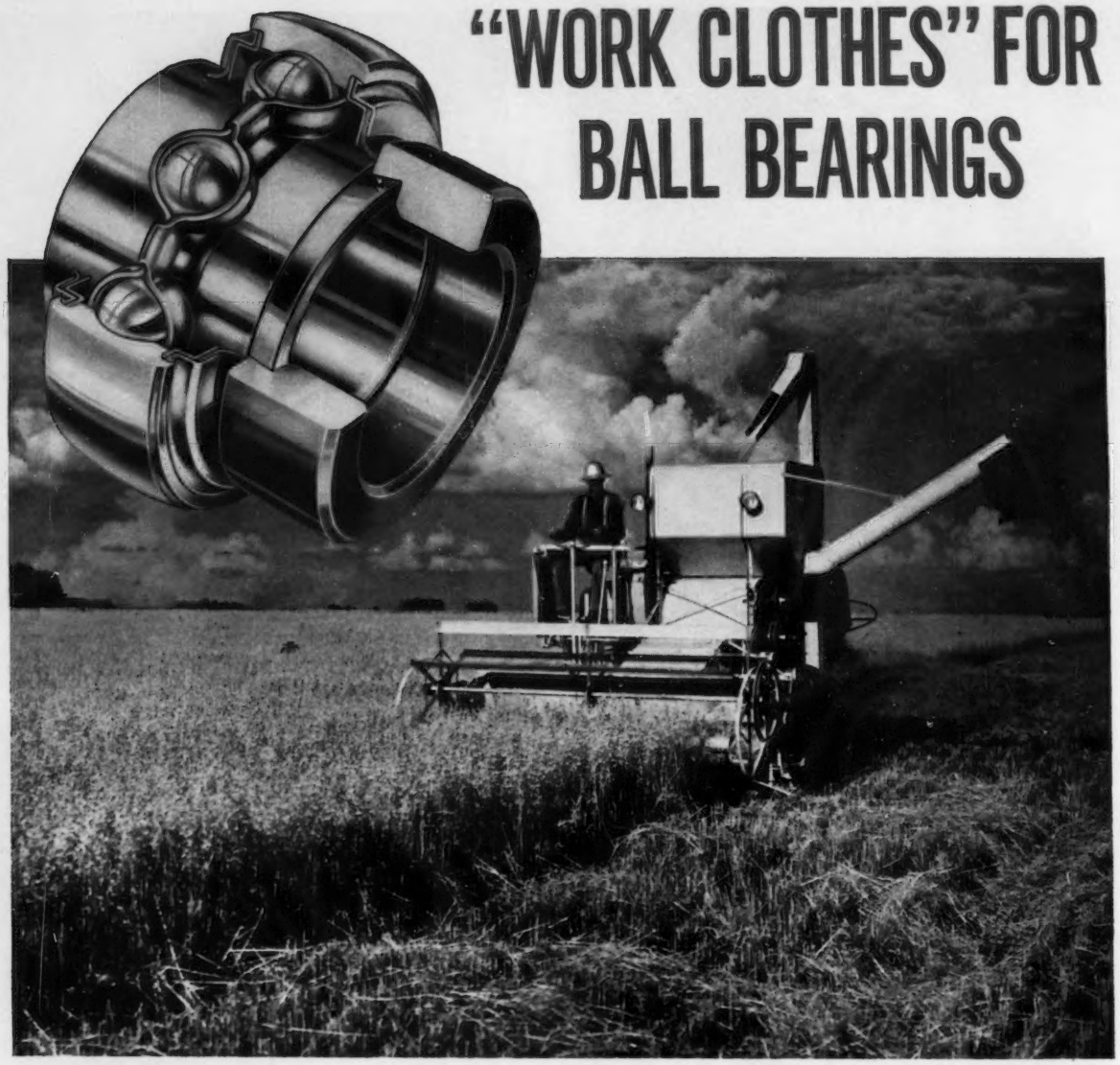

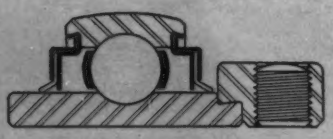

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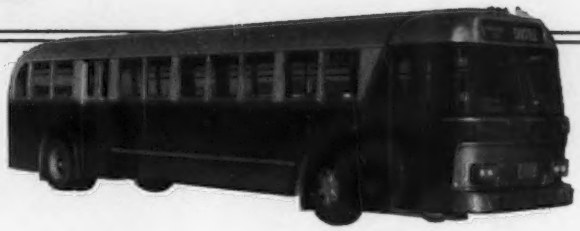

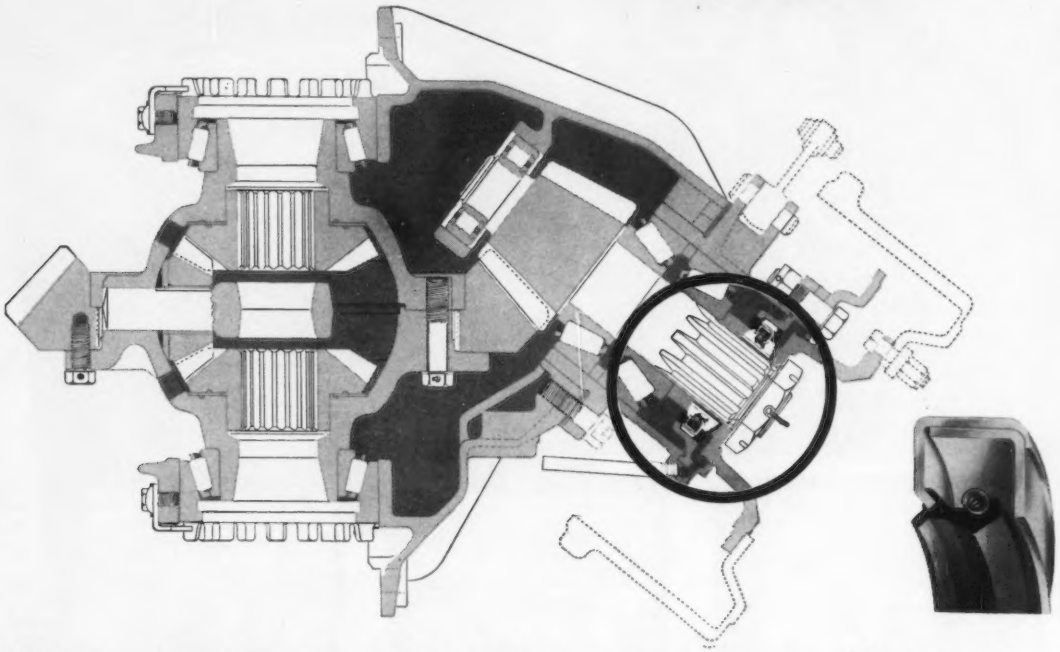

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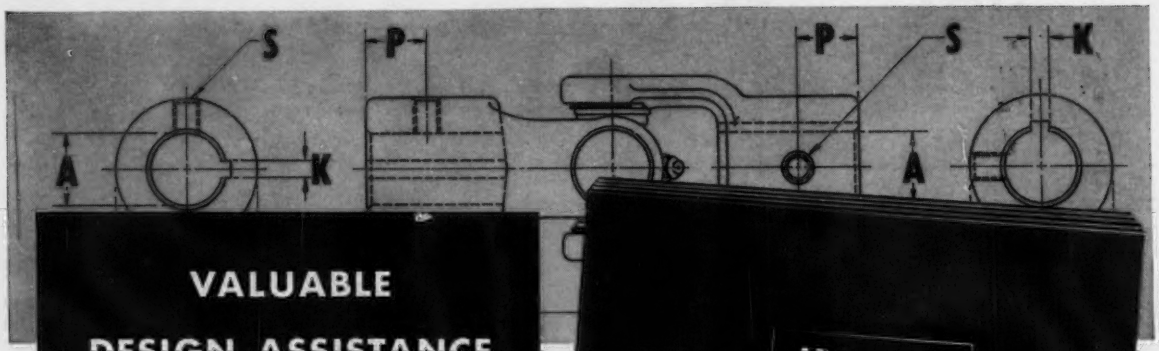

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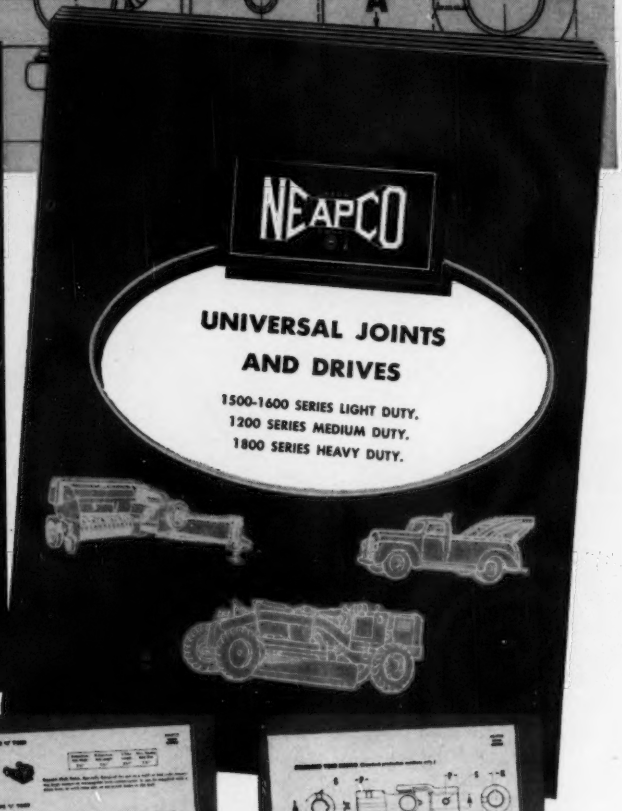

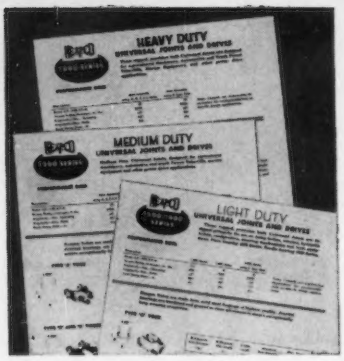

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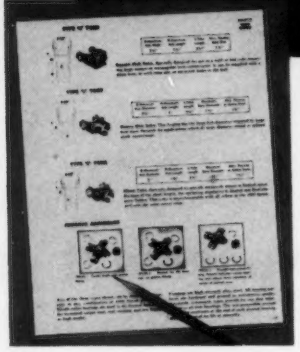

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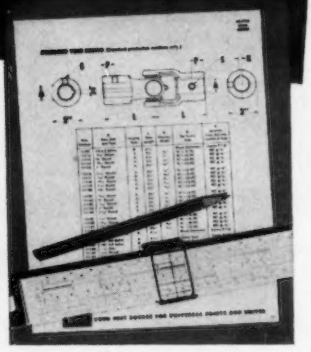

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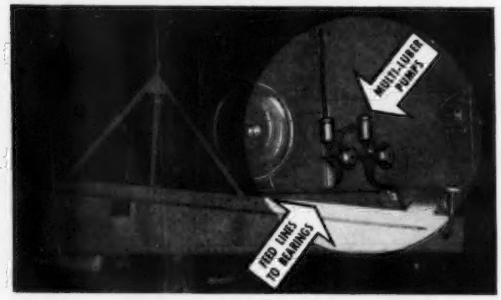

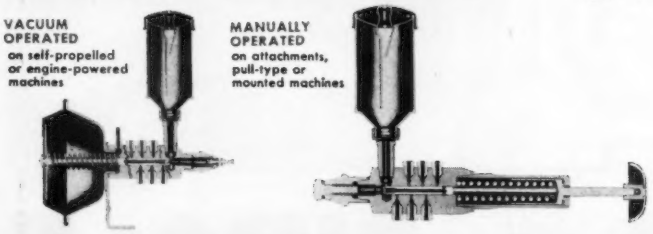

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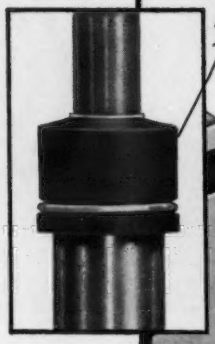

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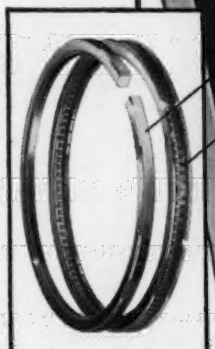

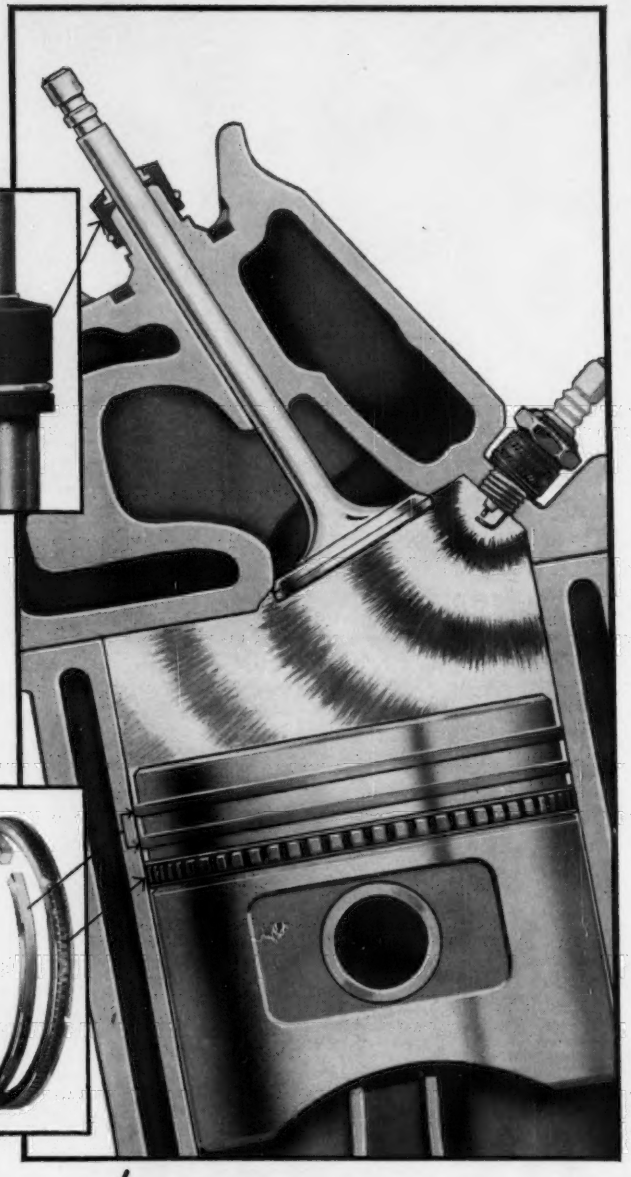

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Hagerstown, Indiana — Don Mills, Ontario, Canada

Agricultural Engineering

August 1959
Number 8
Volume 40

James Basselman, *Editor*

Summary Report of the

SOIL AND WATER DIVISION

THE Soil and Water Division of the American Society of Agricultural Engineers was a dynamic force in its particular branch of agricultural engineering activity during the Society year 1958-59. Much progress was made as a result of the activities of several committees, of technical programs arranged for Society meetings, and of special activities carried on during the year.

The Executive Committee, together with the Steering Committee, directed the over-all affairs of the Division. In addition, 22 subject-matter committees carried on important and timely activities to advance the technology in their respective subject-matter areas, that will reflect greatly to the credit of both the Division and the Society.

Recommendations entitled "Minimum Standards for Irrigation Equipment," were developed by the Committee on Sprinkler Irrigation in conjunction with the Sprinkler Irrigation Association. These were officially approved by the Society and published in the 1959 edition of "Agricultural Engineers Yearbook". Tentative recommendations were prepared covering "Design and Construction of Tile Drains in the Humid Areas" by a committee of that name, which were also given tentative approval and published in the 1959 Yearbook. The Committee on Standards for Irrigation Wells partially completed a report, entitled "Recommended Practices for Irrigation Well Construction." The Division's Committee on Nomenclature, in addition to listing terms in drainage, irrigation, hydrology, and erosion control, also began developing definitions for those terms. The Committee on Erosion Control Research compiled useful data on active research projects being conducted by various research agencies. Other committees conducted studies of various kinds, and participated in sponsoring papers for presentation at national and section meetings of the ASAE.

By-laws relating to the organization and activities of the Soil and Water Division were adopted by the Steering Committee. It is expected that this will contribute to insuring an orderly succession of officers and committee members, and as a result will promote an even smoother functioning of the Society's program.

Six special papers devoted to soil and water subject matter were prepared by ASAE members for presentation at the International Congress of Agricultural Engineering at Brussels, Belgium, September 28 to October 1, 1958. Dwight D. Smith, vice-chairman-elect of the Soil and Water Division, represented both the Division and the Society in the presentation of these papers.

J. R. CARREKER
Past-Chairman,
Soil and Water Division

A special statement on needs in soil and water research was prepared by the Division executive committee and presented to the Task Group of the U.S. Department of Agriculture. This group was appointed by the Secretary of Agriculture to survey and report on the needs of research facilities in soil and water conservation in response to a request from the Congress of the United States. Lewis A. Jones of Washington, D.C., Life Fellow of ASAE, represented the Society in this presentation.

The subject "soil compaction" was the feature of a joint session of the Soil and Water and Power and Machinery Divisions at the ASAE annual meeting in June of this year. Latest research data on this subject were presented in papers, entitled "Soil Deformation and Compaction During Piston Sinkage," "Stress Distribution in Soils Under Tire and Crawler Track Loads," and "Compaction Slippage Effects of Forage Harvesting Machinery." The practical aspects of soil compaction were discussed under the title, "Compaction as Viewed from the Farm."

At both the 1958 and 1959 ASAE Annual Meetings, the Soil and Water Division sponsored a joint program with a group of public land and public works employees. These programs provided ASAE members an opportunity to become better acquainted with soil and water conservation problems in such areas as military installations, airfields, Indian reservations, and other public lands. The other group was in turn provided a forum for discussing their work and presenting special problems to an interested group of agricultural engineers.

The regular soil and water programs at both the annual and winter meetings of ASAE were prepared by the four groups of the Soil and Water Division, namely, Drainage, Irrigation, Hydrology and Erosion Control. Papers presented at these meetings contained information on latest research findings, new techniques, and field application of practices in these four fields of soil and water conservation. The following four examples are typical of these papers: "Fiber-Glass Filters for Tile Drains," "Characterizing Irrigation Water Use by Means of Efficiency Concepts," "Detecting Deeply Penetrating Rainwater with a Neutron-Scattering Moisture Meter," and "Roadside Sediment Production and Control."

Respectfully submitted,

John R. Carreker, Chairman
Ernest H. Kidder, Vice-Chairman
Keith H. Beauchamp, Past-Chairman

Editor's Note: In order to make better known the activities of the various divisions of ASAE the outgoing chairman of each division has been invited to submit a summary report covering the division's accomplishments during his year as chairman. The first to respond was J. R. Carreker, past-chairman of the Soil and Water Division.

Factors Affecting the Pelleting of Hay

J. L. Butler
Member ASAE

H. F. McColly
Member ASAE

- ***Pressure***
- ***Size of pellet chamber***
- ***Length of pellet***
- ***Hay treatment***
- ***Binding materials***

HAY is the most important harvested feed for livestock—average annual production in the United States is about 100 million tons(1)*. Even though it is so important, Kleis(4) found that the greatest labor requirements per ton of all material handled on Michigan livestock farms were for long, loose hay; baled hay; and chopped hay, in that order. Reports by Bruhn(2, 3) and others consider the possibility of compressing hay into small dense units (pellets or wafers). In addition to allowing the complete mechanization of hay handling from the windrow to the feed bunk, such an operation would greatly increase the efficiency of transportation and storage facilities.

Before a machine to perform this operation can be efficiently designed, the effects of the many variables encountered in pelleting hay should be determined. The investigation reported in this paper was undertaken to study the effect of the following variables on the production of hay pellets: *(a)* amount of pressure, *(b)* length of time of pressure application, *(c)* diameter of pelleting chamber, *(d)* length of pellet, *(e)* treatment of hay before pelleting, and *(f)* binding materials. In addition, the handling durability of pellets made from long hay was compared to that of pellets made from chopped hay.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1958, on a program arranged by the Electric Power and Processing Division. Based on doctoral thesis prepared by J. L. Butler while attending Michigan State University. Authorized for publication as Journal Article No. 2353 of the Michigan Agricultural Experiment Station.

The authors—J. L. BUTLER and H. F. MCCOLLY—are, respectively, associate agricultural engineer, Georgia Experiment Station and professor of agr. eng., Michigan State University.

Acknowledgment: The authors express their appreciation to the J. I. Case Co., Racine, Wis., for providing the research grant under which this research was conducted.

*Numbers in parentheses refer to appended references.

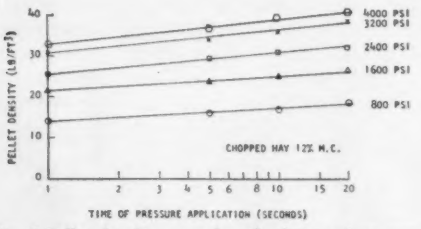

Fig. 1 Pellet density versus length of time of pressure application

Pellets for this investigation were made in cylinder and piston-type compression chambers. The force was applied hydraulically. Electrical strain gage transducers, with amplifiers and a recording oscillograph, were used to measure and record pressure and displacement.

Procedure

Eight pellets were made from alfalfa for each of the variables investigated. Because of the time required to complete a test, it was necessary, in studying the effects of the various variables, to use hay which was at or near an equilibrium moisture content of about 12 percent. When the hay was dried to this moisture level, it was possible, by thoroughly mixing chopped hay, to obtain a sufficient number of samples having a relatively uniform moisture content. Since long hay could not be easily mixed, more difficulty was experienced in obtaining samples having uniform moisture content, even when near the equilibrium moisture. Consequently, more variation in data was obtained with long hay.

The bulk density values were obtained by loosely filling a cubic foot measure with pellets and weighing this volume. Angle of repose was measured by piling pellets on a tilting board arrangement and then tilting the board until enough pellets slid off to expose a continuous surface. A straightedge was placed along this surface and the angle measured. Handling durability was measured by weighing the test pellets before and after a specified number of drops from a height of 6 ft.

Density Relationships

An increase in pellet density was obtained by increasing the length of time of pressure application. When pellet densities were plotted against the logarithms of time of application, straight lines were obtained. From the relatively flat slope of these lines (Fig. 1), it would seem desirable to use a short time of pressure application. For all other results reported in this paper, however, a 5-sec pressure application was used so that any difference in pellet density due to errors in measuring time would be minimized.

Longitudinal expansion of pellets following the release of pressure may be easily detected. In order that valid comparisons of treatments can be made, it is necessary that the duration of expansion be known. As shown in Fig. 2, most of the expansion took place within 15 min after the pressure had been released. After about 30 min the rate of expansion became negligible. Thus, by allowing the pellets to

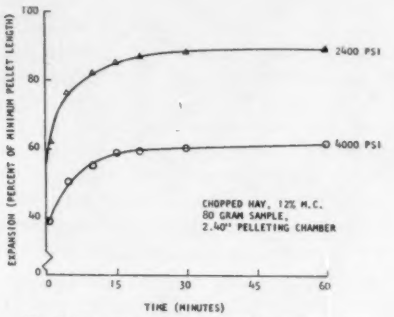

Fig. 2 Percent pellet expansion versus time

stand for at least 30 min after releasing the pressure, differences in measurements due to expansion become insignificant.

Pellet density was found to be linear with the logarithm of the pressure applied and can be represented by an equation of the form

$$\rho = K_1 \ln (P/K_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

where

ρ = pellet density in lb/ft^3.

P = pressure in lb/in.^{2}

and K_1 and K_2 are parameters.

Within the range of these tests, increasing the volume of hay in the pelleting chamber gave an increase in pellet density. This is probably due to an increase in the number of interlocking fibers in the pellet. The fibers at the ends of the pellet are in contact with the pistons, so they would not be interlocked to the same extent as those which are surrounded by other fibers. Since a considerably greater portion of the pellet length is near the ends for thin pellets than for thick ones, thin pellets would have a greater percentage of expansion than thick pellets. This greater percentage of expansion would then cause the thinner pellets to become less dense.

Figs. 3, 4, and 5 show the density versus pressure relationship for pellets of different weights made in 1.50, 2.40 and 3.42 in. diameter chambers respectively. Increase in density was smallest when the sample weight in the 1.50-in.-diameter chamber was increased from 20 to 40 grams. Since the length to diameter ratio was largest for this sample, it is probable that the increase in friction of the material on itself and on the chamber walls absorbed enough of the pressure to compensate for the smaller percentage of the fibers near the ends of the pellet. This would cause the smaller increase in density between the 20 and 40-gram samples in this size chamber than was found when the sample weight was doubled in all other tests.

Pellet density versus pressure for 40-gram samples of hay pelleted in different diameter chambers is shown in Fig. 6. For a given pressure, the pellet density was greater for the smaller diameter chambers. A given weight of hay produced a longer pellet when pelleted in a smaller diameter chamber; hence, a smaller percentage of expansion occurred.

The same tests were conducted using long hay. More variation of moisture content between samples was experienced when using chopped hay; however, these data (as shown for 40-gram samples in Fig. 7) appear linear when plotted on a semi-logarithmic graph. This indicates that an

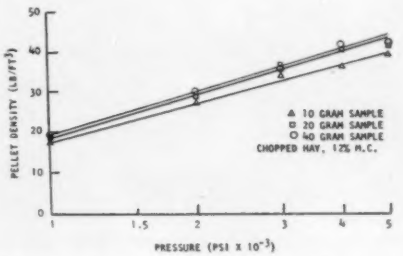

Fig. 3 Pellet density versus pressure—1.50-in.-diameter chamber

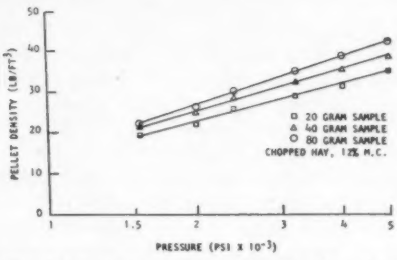

Fig. 4 Pellet density versus pressure—2.40-in.-diameter chamber

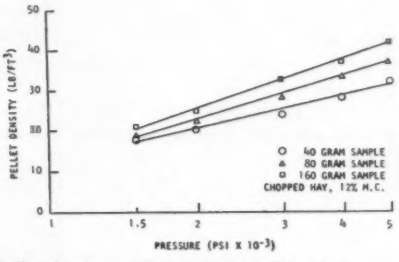

Fig. 5 Pellet density versus pressure—3.42-in.-diameter chamber

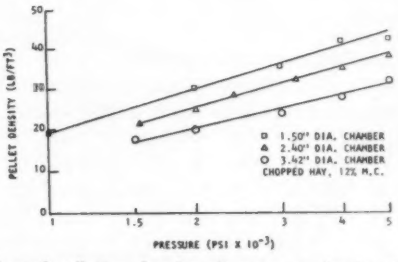

Fig. 6 Effect of pelleting chamber diameter on density of 40-gram chopped hay pellets

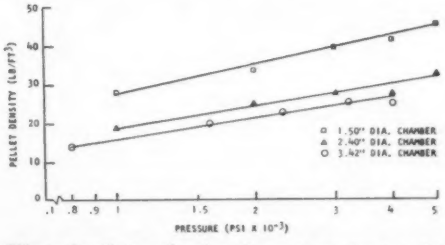

Fig. 7 Effect of pelleting chamber diameter on density of 40-gram long hay pellets

Fig. 8 Effect of sample weight on pellet density. All pellets made in 3.42-in.-diameter chamber with 4000-psi pressure. Left to right: Four 40-gram pellets; two 80-gram pellets; and one 160-gram pellet

equation of the same form as Equation[1] may also be used to express the density-pressure relationship for long hay. The effect of sample weight on pellet density for long hay pelleted in the 3.42-in.-diameter chamber using a pressure of 4000 psi is shown pictorially in Fig. 8.

Eighty-gram samples of long hay were pelleted with 5000 psi pressure in the 2.40-in.-diameter chamber to determine the effect of moisture content. Pellet density (adjusted to 15 percent moisture content, w.b.) versus moisture content is shown in a semi-logarithmic plot in Fig. 9. Considering 20 lb per cu ft to be the minimum desirable pellet density, it may be seen from Fig. 9 that, with the conditions specified, this density may be obtained when the moisture content of the hay at the time of pelleting is less than 26 percent.

Three binding agents, bentonite, Ceredex No. 265, and blackstrap molasses, were used to determine their effectiveness in increasing pellet density. Under the test conditions, neither bentonite nor Ceredex No. 265 was effective in increasing pellet density. Although some increase in density was obtained by the addition of 5 and 10 percent blackstrap molasses, the molasses formed a coating on the piston and chamber walls, resulting in high frictional forces. For this reason, blackstrap molasses does not appear to be desirable for use in this type of pelleting operation.

Energy Requirement Relationships

Pressure and displacement data for the 20, 40 and 80 gram samples of hay pelleted in the 2.40-in.-diameter chamber were taken from the oscillograph chart record and plotted in Fig. 10. There was no discernible difference

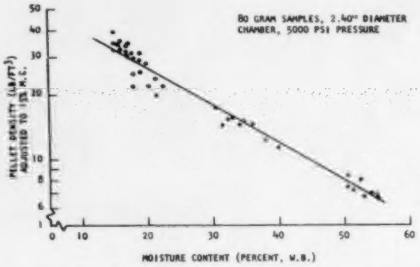
80 GRAM SAMPLES, 2.40" DIAMETER CHAMBER, 5000 PSI PRESSURE
PELLET DENSITY (LB/FT³) ADJUSTED TO 15% M.C.
MOISTURE CONTENT (PERCENT, W.B.)

Fig. 9 Pellet density versus moisture content

between long and chopped hay with the 20 and 40-gram samples. With the 80-gram samples, the slope of the curve was more gradual for long hay, indicating a greater energy requirement. The area under each of these curves was measured with a planimeter. The energy, in foot pounds, required for pelleting, was found by multiplying this area by 376.6 (a constant obtained by combining the scale modulus of the ordinate, the cross-sectional area of the pelleting chamber and the inches to feet conversion factor). The values found by this method were 150 and 280 ft lb for the 20 and 40-gram samples respectively. For the 80-gram samples, the values were 460 and 650 ft lb for chopped and long hay respectively.

Dividing the preceding values by the sample weight and multiplying by 0.458 (a constant obtained by combining the unit conversion factors) gives the power requirement necessary to produce these pellets using a pressure of 5000 psi. For chopped hay these values are 3.4, 3.2 and 2.6-hp-hr per ton for the 20, 40 and 80-gram samples, respectively. A value of 3.7 hp-hr per ton is obtained for the 80-gram sample of long hay. Thus, it appears that the power requirement per unit of weight of chopped hay decreases as the sample weight is increased. The converse is true for long hay.

In order to get a clearer understanding of the preceding phenomenon, consider a 40-gram sample weight pelleted in each of the three different diameter chambers. The pressure versus displacement relationship is shown in Fig. 11. It must be remembered in observing this graph that the ordinate is expressed in psi, not in pounds force. For the displacement shown for the 3.42-in.-diameter chamber almost 46,000 lb of force were required. Less than

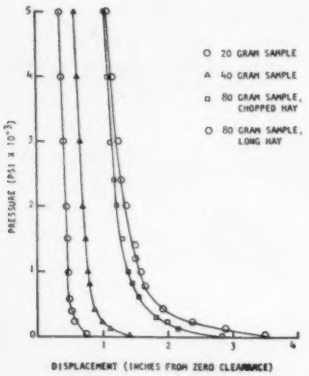
20 GRAM SAMPLE
40 GRAM SAMPLE
80 GRAM SAMPLE, CHOPPED HAY
80 GRAM SAMPLE, LONG HAY
PRESSURE (PSI x 10⁻³)
DISPLACEMENT (INCHES FROM ZERO CLEARANCE)

Fig. 10 Pressure versus displacement for hay pelleted in 2.40-in.-diameter chamber

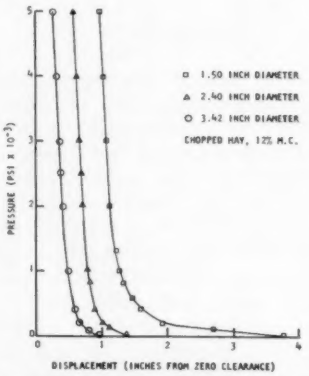

Fig. 11 Pressure versus displacement for 40-gram samples pelleted in different size chambers

9000 lb of force were required for the 1.50-in.-diameter chamber.

The area under each of the curves in Fig. 11 was measured and converted to a horsepower hour per ton basis. These values are 2.2, 3.2, and 5.7 hp-hr per ton for the 1.50, 2.40 and 3.42-in.-diameter chambers, respectively. Thus, increasing the size of pelleting chamber without changing the sample weight increased the power requirement per unit of weight. This may be explained as follows: When the 40-gram sample was placed in the larger diameter chambers, it filled a proportionately smaller depth. As the piston compressed the sample, considerable resistance was encountered well before the cross section of the chamber was filled, thus increasing the power requirement per unit weight of the sample.

Since the average maximum pressure over the chamber cross section was 5000 psi, an amount considerably greater than this was exerted over the lower portion of the pellet in the horizontal pelleting chamber, while the upper portion of the pellet received very little pressure. The wedge-shaped appearance of the 40-gram pellet produced in the 3.42-in.-diameter chamber and shown in Fig. 12 verifies this. The thin portion of the pellet, which was in the lower part of the chamber, is very dense. The thick portion, which was in the top of the chamber, is quite loose.

This same reasoning may be applied to the different sample weights pelleted in the 2.40-in.-diameter chamber. As the sample size was increased, more nearly uniform distribution allowed a more efficient utilization of energy, thus reducing the power requirement per unit of weight. This probably also explains the reason no difference in the pressure versus displacement curves could be detected between long and chopped hay when 20 and 40-gram samples were pelleted in the 2.40-in.-diameter chamber. Better distribution across the chamber cross section was obtained with long hay. This better distribution was offset, however, by the increased resistance to compression offered by long hay. When 80-gram samples were pelleted, good distribution was obtained with both long and chopped hay; hence, the power requirement per unit of long hay was greater since it offered more resistance to compression. The uneven pressure distribution across the chamber cross section could be another reason for lower density of the smaller sample weights. Since the pellet density is linear with the logarithm of the pressure applied, the pellet density (for a given average pressure) would decrease as the difference between pressure on the top and bottom of the pellet increased.

Uneven Pressure Distribution

This factor of uneven pressure distribution with the pelleting of small amounts of hay in large diameter chambers would be of considerable importance in the design of a pelleting machine. The unevenness of distribution of hay could be minimized by mounting the compression chamber in a vertical position. To completely eliminate it, even with the chamber mounted vertically, the feeding mechanism must be designed to distribute hay evenly across the chamber cross section.

When considering the power requirements listed earlier, it should be remembered that they are for compressing the hay only. When the power requirements for all the component parts necessary for a field pelleting machine are considered, the total power necessary will probably be in the range of three times the amounts indicated in these tests. These results indicate, assuming uniform distribution of hay in the pelleting chamber, that more power will be required to make pellets from long hay than from chopped hay if the power required for chopping is neglected. When one considers the power necessary for chopping, this situation may be reversed.

Fig. 12 Wedge-shaped appearance of 40-gram pellet made in 3.42-in.-diameter chamber

Handling Characteristics

The results of preliminary tests conducted to determine the pellet density-bulk density relationship and angle of repose for pellets with varying length to diameter ratios are shown in Table 1.

TABLE 1. COMPARISON OF PELLET DENSITY-BULK DENSITY RELATIONSHIP AND ANGLE OF REPOSE*

L/D ratio	Pellet Density lb/ft³	Bulk Density lb/ft³	Void ratio	Angle of Repose, degrees
0.20	35.8	20.8	0.42	55
0.35	38.2	23.2	0.39	44
0.60	42.8	28.0	0.34	40

*For chopped hay pelleted in a 2.40-in.-diameter chamber with a pressure of 5000 psi.

Since these values were obtained using small samples, they should be used only to establish trends. Since the wedging effect caused by additional weight of larger quantities would probably have considerable effect on these values, the above tests will have to be conducted with large samples before the values can be established.

Theoretically the void ratio would be smallest when the length and diameter of the pellet were equal. From Table 1, it may be noted that a trend along this line is established. This indicates that with a given pellet density, less storage space per ton of hay would be required for thick pellets than for thin ones.

The angle of repose shows a decreasing trend as the pellet length to diameter ratio increases. This is due to a larger percentage of the pellets falling in a position from which they can roll rather than slide. Because of this, the angle of repose should continue to decrease as the length to diameter ratio approaches unity. One would expect the angle to increase as the length to diameter ratio is made greater than unity. Thus, if the material is to flow freely, it appears that the length to diameter ratio should be made as nearly equal to unity as practical.

Both long and chopped hay pellets with approximately the same density were subjected to the same number of drops from a height of 6 ft. In each instance, the pellet was dropped on bare plywood, making the treatment somewhat more severe than would be expected in actual practice. Table 2 shows a comparison of the handling durability as determined by this method.

. . . Hay Pelleting

TABLE 2. COMPARISON OF PELLET HANDLING DURABILITY

Type of hay	Pellet density, lb/ft³	Percent of weight remaining Number of 6-ft drops			
		1	3	5	7
Long*	33.9	99.7	99.6	99.5	99.5
Chopped*	32.3	98.8	87.5	73.0	59.5
Long†	28.3	99.6	99.5	99.3	99.1
Chopped†	29.5	74.5	52.6	41.0	21.6

*160-gram sample pelleted in 3.42-in.-diameter chamber.
†80-gram sample pelleted in 2.40-in. diameter chamber.

From the values in Table 2, it is apparent that the handling durability of long hay pellets is far superior to that of chopped hay pellets. Fig. 13 shows the condition of long and chopped hay pellets before and after being subjected to this durability test.

In actual practice, chopped hay pellets would probably retain a higher percentage of their weight than that shown above, because all the pellets except the first few would have their fall cushioned by other pellets. If the pellets are to be handled many times, however, they should be made from long hay.

Fig. 13 Appearance of long and chopped hay pellets before and after being subjected to handling durability test. Pellets are *(left to right)* Long hay, not dropped; density=33.9 lb per cu ft; Long hay, dropped 7 times from a height of 6 ft; Chopped hay, dropped 7 times from a height of 6 ft; Chopped hay, not dropped; density=32.3 lb per cu ft

Summary

Compressing hay into small, dense pellets or wafers appears to be a way of changing the form of hay so that it can be mechanically handled and at the same time allow more efficient utilization of transportation and storage facilities.

Pellets made in cylinder and piston type compression chambers indicate the following:

1. The density of pellet obtained is linear with the logarithm of the pressure applied.

2. Increasing the volume of hay in the pelleting chamber gave an increase in pellet density.

3. The density of pellet obtained is linear with the logarithm of the time of pressure application.

4. The unit power requirement for chopped hay decreased as the sample weight increased; whereas, the converse is true for long hay.

5. Uneven distribution of hay across the pelleting chamber cross section, which occurs when making thin pellets, increased the power requirements.

6. Firm pellets, which will withstand mechanical handling, can be produced from long hay having a moisture content less than 26 percent by the application of 5000 psi.

7. The use of binding materials to increase pellet density does not appear to be practical.

8. Pellets made from chopped hay are more uniform in size, shape and density than those made from long hay.

9. In the tests made, pellets made from long hay will withstand more severe handling than pellets of equal density which are made from chopped hay.

10. Pellets having a length to diameter ratio approaching unity have better flow characteristics and greater bulk density for a given pellet density than do thin pellets.

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Ohio State Upgrades Engineering Status

A RECENT academic reorganization of the Ohio State University College of Engineering resulted in an establishment of a pre-engineering division for the first two years of pre-professional study and a professional division for the final three years of the five-year program. Graduation requirements are based on the successful completion of the work of the professional division. Curricular changes will go into effect autumn quarter, 1959.

Under the new plan students will be admitted to the professional division of the college upon completion of a two-year pre-engineering program. The pre-engineering studies may be taken in the pre-engineering division of Ohio State's college of engineering, or at accredited liberal arts colleges, including the Ohio State College of Arts and Sciences, branch campuses, and any other colleges and universities offering a comparable curriculum in pre-engineering.

The pre-engineering curriculum will be common for all branches of engineering, with the exception that students who expect to enroll in any of the chemically based curricula in the professional division will schedule two courses in quantitative analysis which would not be required of students who enter any of the other professional curricula. The program in pre-engineering will include work in English, mathematics, physics, chemistry, engineering drawing, and engineering mechanics. Also included is the equivalent of nearly one quarter's work in the humanities and social sciences and the university requirements in physical education and military science. Admission to the professional division will be contingent upon completion of this work, or its equivalent, with an average grade of "C" or better.

Iowa State Becomes a University

ON July 4 Iowa State College of Agriculture and Mechanic Arts officially became Iowa State University of Science and Technology. The change from college to university, which occurred in the first year of the institution's second century, resulted also in changing divisions of the school to colleges. Thus there will be a College of Agriculture, College of Engineering, College of Home Economics, College of Sciences and Humanities, and College of Veterinary Medicine. Present enrollment ranges between 9,000 and 10,000 students. It is reported, however, that a strong bulge in the early 1960's is expected to carry this figure upward by from 3,500 to 5,000.

Spray Characteristics of Converging Sprinkler Nozzles

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More uniform distribution patterns and wider sprinkler and lateral spacings result from systems of converging nozzles

THE primary function of sprinklers in an irrigation system is to distribute water uniformly over a design area at a rate equal to or less than the intake rate of the soil. The ideal sprinkler would distribute water uniformly over a relatively large square or rectangular area, thus reducing the number of sprinkler settings as well as reducing the number of sprinklers required.

To cover a relatively large area from a given lateral line, it is necessary to project the water a considerable distance from the sprinkler. This requires a mass of water of such volume that the instantaneous application rate greatly exceeds soil infiltration rates. Rotation of the sprinkler reduces the average application rate of the same order of magnitude as the infiltration rate. Rotation, however, results in a circular wetted area, which introduces the problem of designing the system to provide maximum uniformity by overlap of the circular patterns.

This problem would not be great if the distribution pattern from a rotating sprinkler were a circular conic pattern with the maximum application of water per unit area at the center and with a uniform reduction of water applied toward the periphery of converage. This circular conic pattern on a square-grid system, such that the periphery of one conic section of application touches the next sprinkler on the lateral, would result in a fairly uniform field application if no other disturbing factors were present.

Objectives

The purpose of this study was to determine which of various arrangements of circular nozzles would produce a circular conic distribution pattern or other geometrical pattern that would result in a uniform distribution of water.

Studies by Hall and Boving (3)* on triangular orifices showed that water issuing from an orifice of this type with a 1:1 height-to-base ratio approached the ideal conic distribution pattern and resulted in more uniform, medium drop sizes. In view of the foregoing results, it was decided to study three converging circular nozzles so placed as to represent the three apexes of an equilateral triangle. This arrangement might result in some desirable unbalance of radial forces, causing an improved distribution pattern — and at the same time take advantage of the hydraulic properties and ease of manufacturing of circular nozzles.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1958, on a program arranged by the Soil and Water Division.

The authors — JOHN M. LANGA and JOHN R. DAVIS — are, respectively, irrigation technician, Hawaiian Commercial & Sugar Co., and associate irrigation engineer, department of irrigation, University of California (Davis).

*Numbers in parentheses refer to the appended references.

The following variables and their effects on distribution patterns were studied:

1. The angle of separate nozzles with respect to the main axis of the three nozzles (angle of impingement) (10 and 20 deg)
2. The angle of elevation of the main axis (0, 20 and 30 deg)
3. Nozzle pressure (30, 40, and 50 psi)
4. Arrangement of one nozzle pointed upward toward the main axis to two nozzles pointed upward toward the main axis.

Those factors held constant were:

1. Distance of impingement (from the plane of the nozzles to the point of impingement), ¾ in.
2. Height of the riser, 2.5 ft
3. Size of nozzle, (three ⅛-in. circular nozzles)
4. Wind speed (indoors, wind negligible)
5. Rotational speed (non-rotational).

It can be hypothesized that an increase in nozzle pressure would cause an earlier breakup of the nozzle stream, as well as a change in drop size. Changing the impingement angle also creates changes in the stream breakup, but changes in nozzle diameter and length of the stream before impingement should have only small effects (4). This earlier breakup of the stream, caused by an unbalance of radial forces, should improve the distribution of water over that of a single circular nozzle (2, 5).

Experimental Methods and Procedure

A three-nozzle test stand was designed to permit easy adjustment of the angle of impingement, the angle of elevation of the main axis, and impingement distance. Three ⅛-in. diameter nozzles were attached to three 36-in. lengths of ⅛-in. galvanized pipe, which were mounted rigidly to the frame of the stand and which could be adjusted to the desired angle of impingement.

Water was supplied to these lengths of pipe from a pressure-control valve through equal lengths of garden hose. The nozzles with pipe and hoses attached were calibrated for discharge at different pressures. All tests were conducted indoors in a closed shed.

To determine the water distribution patterns from the nozzles, sharp-edged rectangular collecting troughs 0.3 ft wide were placed at three-foot intervals along the radius. After the equipment was adjusted for each test condition, water was allowed to run for three minutes to wet the troughs and to fill any storage in the troughs. The stream of water was then diverted and the troughs allowed to drain completely. Stoppers were then placed in each drain, and the water collected during a three-minute period. Three replications of each condition were made. The volume of

Fig. 1 *(Left)* Detail of converging nozzles, showing the fans developed by the impinging jets. Angle of impingement is 10 deg, using ⅛-in. nozzles at 40 psi. • Fig. 2 *(Center)* The slotted plate permitted easy, accurate adjustment of the angle of impingement. Each nozzle received water from a hose connected to a pressure-control valve. • Fig. 3 *(Right)* Sampling troughs 0.3 ft wide were spaced in three-foot increments from the nozzles. Actual tests were made indoors to minimize effects of air movements

. . . Converging Sprinkler Nozzles

water collected in each trough was then measured to the nearest 5 cubic centimeters.

The volume of water thus obtained was converted to rate of precipitation at each point along the radius.

Results

Jet Breakup. Water emerged from individual nozzles as circular jets, with no apparent vena contracta. The jets appeared to be well-balanced and had no tendency to form droplets prior to impingement. Upon impingement, however, immediate signs of breakup appeared and a flattening of the water surface developed.

A fan of water formed opposite each jet stream similar to the flats and fans observed by others. These fans are expanding and are broken down rapidly into droplets by attenuation.

Increasing the impingement angle above 20 deg caused water to be deflected in a reverse direction with considerable discharge laterally. Above 30 deg, water was deflected behind the test stand in large quantities.

Distribution Patterns. The distribution patterns of water from the nozzles operating under the specified test conditions are shown in Fig. 4. Included is the distribution pattern of a standard 7/32-in. non-rotating sprinkler, operating without an interrupter. The rate of application is shown as a function of range ratio, which is defined as the ratio of the radial distance of a collecting trough to the maximum wetted radius. Use of the range ratio in preference to actual radial distance permits a direct comparison of distribution patterns from the variety of test conditions.

In all cases, a change in operating pressure from 30 to 50 psi had little or no effect on the distribution pattern. The patterns shown, therefore, are average patterns over this pressure range. Increasing the operating pressure caused an increase in the wetted radius, however.

Comparisons of the distribution patterns show that an increase in the angle of impingement *(i)* caused a greater accumulation of water near the sprinkler. This is probably due to a reduction in the horizontal component of velocity as the impingement angle increases, and to the production of finer droplets which do not travel as far as the larger droplets.

Changing the angle of elevation *(e)* between 20 and 30 deg had little effect on the shape of the distribution patterns. However, a change from 0 to 20 deg had a considerable effect on the patterns, such that the distribution was more uniform at the higher angle of elevation.

The arrangement of the nozzles should have little effect on the drop size distribution, but should create some differences in the magnitude of the vertical and horizontal components of the resulting velocities after impingement. The arrangement of one nozzle pointed upward toward the main axis ▽ resulted in a smoothing of the distribution patterns and a decrease in the wetted radius.

It can be noted in the figure that certain arrangements of three impinging nozzles resulted in much better distribu-

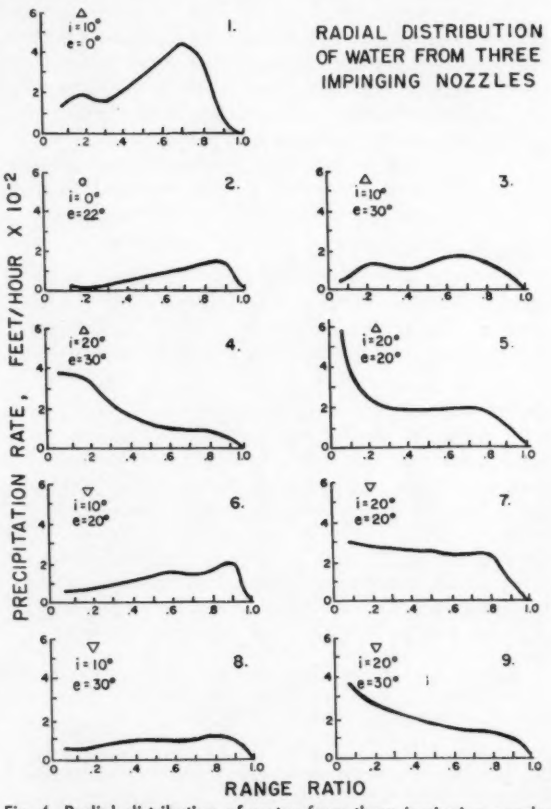
RADIAL DISTRIBUTION OF WATER FROM THREE IMPINGING NOZZLES
PRECIPITATION RATE, FEET/HOUR X 10⁻²
RANGE RATIO
1. △ i=10° e=0°
2. ○ i=0° e=22°
3. △ i=10° e=30°
4. △ i=20° e=30°
5. △ i=20° e=20°
6. ▽ i=10° e=20°
7. ▽ i=20° e=20°
8. ▽ i=10° e=30°
9. ▽ i=20° e=30°

Fig. 4 Radial distribution of water from three impinging nozzles

tion patterns than those from a single circular nozzle without an interrupter. These results also imply that by changing the geometry of the three impinging jets, the direction of the momentum can be changed, thus almost any distribution pattern that would lend itself to a practical field spacing may be obtained.

Uniformity of Distribution. The distribution curves were extrapolated to obtain isohyetal lines of precipitation over a circular area. Uniformity coefficients were then calculated by the shortcut method described by Christiansen (1), using a 10 percent spacing along the lateral and varying the spacing between laterals.

Table 1 lists the uniformity coefficients of these distribution patterns as affected by nozzle geometry, pressure and spacing.

Triangular distribution patterns with the greatest accumulation of water in the center resulted in a high uniformity coefficient and a practical spacing at 50 to 60 percent of the wetted diameter. However, the flat distribution pattern allows a greater spacing for the same high uniformity coefficient, thus providing better economy on lateral moves and the number of sprinklers needed.

In all cases, the distribution of water from the three impinging jets was more uniform than that from a single circular nozzle without an interrupter; to some extent, the wetted radius was smaller. Nozzle arrangements with a 10-deg angle of impingement and a 30-deg angle of elevation, for example, would produce a distribution with a 90 percent uniformity coefficient at a spacing of about 36 ft, whereas single circular nozzles would have to be spaced about 20 ft apart for the same uniformity.

The effect of the arrangement of nozzles on the wetted radius is related to the angle of impingement.

These data show conclusively that certain arrangements of impinging jets created more desirable distribution patterns of water than a single circular nozzle, and allowed for a greater spacing of sprinklers.

Summary and Conclusions

A variety of distribution patterns were obtained through the use of impinging jets resulting from a system of three converging nozzles. In all cases, the uniformity of distribution of water was better with impinging jets than with a single circular nozzle. At the same time, the wetted radius of the impinging jets was less than a corresponding single circular nozzle. The effect of this latter result, in terms of sprinkler and lateral spacing, can be overcome by the improved distribution pattern resulting from impinging jets.

From this study it can be tentatively concluded that more uniform distribution patterns, coupled with wider sprinkler and lateral spacings can result from the use of a system of converging nozzles, thus obtaining the advantages of non-circular orifices, while retaining the advantages of circular nozzles.

Before final conclusions can be drawn, further comparisons of drop sizes and water distribution as affected by wind will be necessary to completely assess the merits of an impinging jet system of nozzles.

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TABLE I. UNIFORMITY COEFFICIENTS AND WETTED RADIUS

Nozzle Conditions				Uniformity Coefficient							
				Spacing between laterals, percentage of wetted diameter							
Arrangement	Angle of impingement	Angle of elevation	Pressure, psi	80	70	60	50	40	30	20	Wetted radius, ft
△	10	0	30	76	89	69	61	76	87	83	27
			40	81	82	71	60	78	90	94	27
			50	90	75	68	71	96	97	96	27
△	10	30	30	94	86	81	82	99	93	99	39
			40	94	86	78	77	98	98	99	42
			50	90	90	78	80	96	94	100	45
△	20	30	30	66	79	93	93	91	97	99	40
			40	65	80	88	93	86	90	90	43
			50	58	72	88	95	94	95	100	45
△	20	20	30	86	88	87	90	93	94	96	34
			40	80	89	90	94	87	94	94	36
			50	77	89	90	94	92	95	95	39
▽	20	20	30	89	91	85	83	96	97	96	30
			40	80	93	90	87	98	97	98	33
			50	83	93	88	86	96	98	97	33
▽	20	30	30	77	92	93	90	95	98	95	36
			40	76	90	93	93	92	97	94	39
			50	74	88	94	95	95	94	96	42
▽	10	30	30	86	76	69	73	91	100	92	44
			40	89	82	73	76	92	100	92	49
			50	90	85	75	77	93	100	93	52
▽	10	20	30	83	75	67	70	89	100	90	36
			40	84	77	67	72	89	98	90	40
			50	87	79	70	74	91	100	92	43
O	0	22	30	69	55	53	63	80	99	88	45
			40	76	63	56	64	87	99	89	51
			50	83	67	61	67	91	99	93	56

Performance Characteristics of Inclined Screw Conveyors

William M. Regan and S. Milton Henderson
Member ASAE

FILLED screw conveyors are frequently operated at inclinations and speeds above those for which reliable performance data are readily available. This is especially true in agriculture where simple portable screw conveyors are used extensively for transferring small grain (and other products). The authors made a study of the screw conveyor *(a)* to gain additional insight into its general performance from the standpoint of capacity and power required at various speeds and inclinations and *(b)* to develop various engineering features of interest to the designing engineer.

The results pointed up some specific factors that appear to affect the performance of inclined screw conveyors. Even though the results are not conclusive, the findings extend the knowledge of screw conveyors and will be of interest to those interested in this method of conveying.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1958, on a program arranged by the Power and Machinery Division.

The authors — WILLIAM M. REGAN and S. MILTON HENDERSON — are, respectively, design engineer, Food Machinery and Chemical Corp., and professor of agricultural engineering, University of California (Davis).

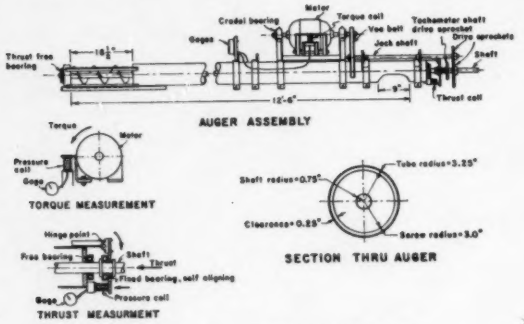


Fig. 1 Auger assembly used in study

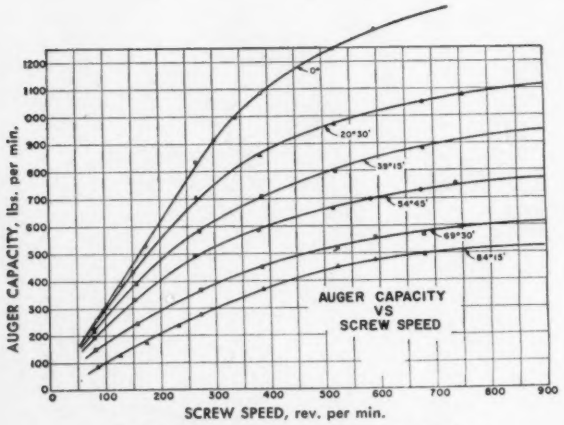


Fig. 2 Auger capacity versus screw speed

Factors affecting general performance in agricultural applications

The assembly used in the study is shown in Fig. 1. The pressure cells and gages used to observe motor torque and screw thrust were calibrated as assembled units. Energy loss in the drive connecting the motor and the screw was computed and each run corrected accordingly. Grain was conveyed from a 90 cu ft bin in which the pickup end of the conveyor was buried to a smaller bin from which capacity was determined gravimetrically. Barley, which was used for study, had the following characteristics: weight per bushel, 41.6 lb (33.2 lb per cu ft); 8½ percent foreign material; coefficients of friction, barley on polished iron, 0.364; barley on barley, 0.554.

The results of the investigation are shown in Figs. 2 to 7. Basic equations were developed for the performance of a screw elevator, assuming that the grain mass was undisturbed, that is, did not mix as it was conveyed. Even though the investigators realized this to be a false premise, they hoped the computed and observed results would be sufficiently compatible to be mutually substantiating. Such, however, was not the case, so the basic treatment will not be reviewed in this paper.

Capacity

The capacity (Fig. 2) appears to approach a maximum at approximately 1,000 rpm. Miller and Rehkugler (1)* found the maximum capacity to occur at approximately 800 rpm, when conveying wheat and oats with both 4-in. and 6-in. screws; they observed a tendency for the capacity to decrease at speeds in excess of 800 rpm.

Since the maximum capacity occurred at the same rotative speed irrespective of inclination (also observed by Miller and Rehkugler), two factors are proposed as capacity limiters: *(a)* the maximum possible rate of grain flow through an orifice (the entrance to the conveyor) and *(b)* the centrifugal force due to rotation of the grain mass. The rate of flow of grain, as well as other granular material, through an orifice or hole is independent of the head and varies approximately as the third power of a representative dimension of the orifice (3). Tests have shown that barley will flow from a hole 16½ in. by 6½ in. which is the projection of the uncovered end of the conveyor at a rate of approximately 2,000 lb per min (3). A 6-in. screw operating above 200 rpm will exert sufficient centrifugal

*Numbers in parentheses refer to the appended references.

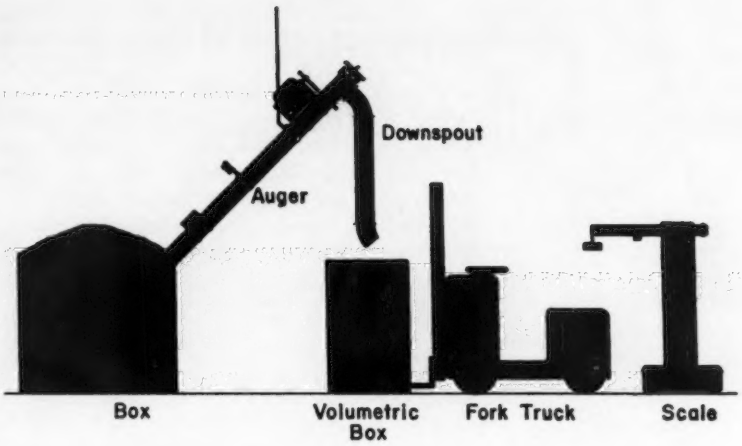
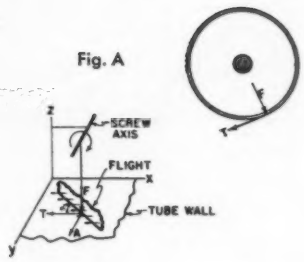


Fig. A



force computed to throw the grain vertically out of the conveyor. The force would oppose the grain flowing into the screw and, conceivably, could become great enough at higher rotative speeds to inhibit the inward flow of grain by gravity. This concept is strengthened by the observation that the capacity at zero degrees inclination is directly proportional to speed up to about 250 rpm, above which the slope decreases as speed increases. Further evidence is the observation by Miller and Rehkugler (1) that speeds above 800 rpm may cause a reduction in capacity.

Fig. 3, showing relative capacity, presents some interesting results. The cosine (dotted) curve can be used as a performance reference since many physical phenomena vary as the cosine of the angle inclination. However, the two factors, centrifugal force and the rate of flow from an inclined orifice discussed above, are probably effective in causing deviation from the cosine law. Grain flows from a vertical orifice at approximately one-third the rate from a comparable horizontal orifice(3) rather than at zero rate as the cosine law would indicate. At low rotative speeds the capacity is probably a function of the rate of flow into the screw through an orifice. The reduction in capacity below the cosine line is believed due to the centrifugal forces at higher speeds, particularly since the speeds are above the 200 rpm limit previously established. The authors have no firm opinion for the combining of the curves at 85 to 90 deg inclination; note, however, that the capacity is approximately one-third that when horizontal which implies a possible relationship to the incoming flow-rate effect.

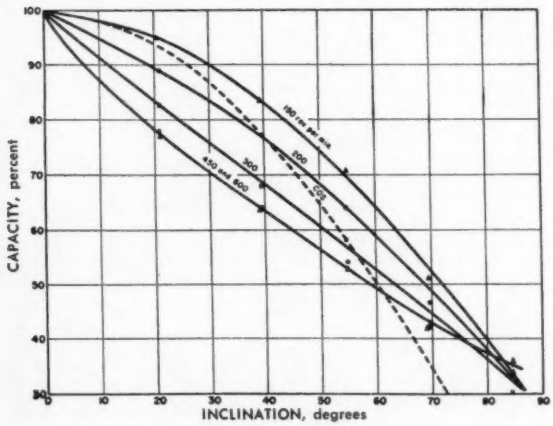


Fig. 3 Capacity versus inclination

Volumetric Efficiency

The volumetric efficiency (Fig. 4) is assumed to be the percent fill of the conveying space. Note, however, that turning or mixing of the grain mass as it is screwed through the tube has the same effect on the computations as lack of fill. Fig. 4 is composed, no doubt, of both of these factors, the mixing factor becoming more influential as the conveyor is inclined. The volumetric capacity of the near vertical conveyor decreased after the screw speed had exceeded 300 rpm. The centrifugal effect may be responsible for the reduction at speeds above 300 rpm.

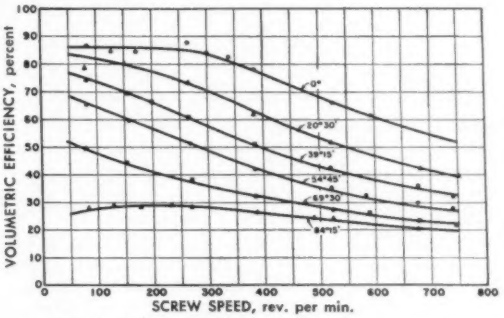


Fig. 4 Volumetric efficiency versus screw speed

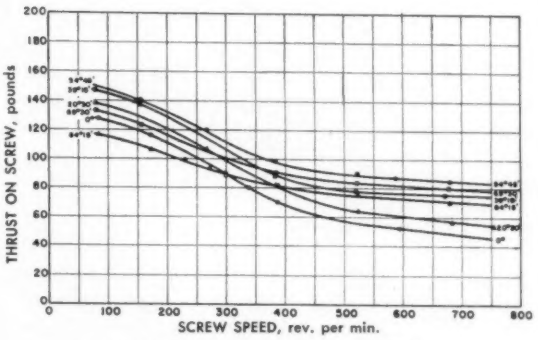


Fig. 5 Screw thrust versus screw speed

. . . Inclined Screw Conveyors

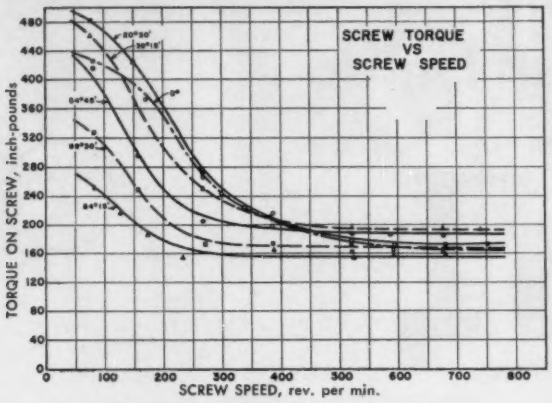


Fig. 6 Screw torque versus screw speed

Thrust and Torque Force

The thrust and torque force, if the grain mass did not mix, could be resolved into components defined by the slope of the screw at the maximum radius, $1/\pi$ or 0.318 in this case. Thus α in illustration A would be $\tan^{-1}$ 0.318 and the axial force A would be 0.318 of the torque force T. A study of Figs. 5 and 6 will show that this relationship does not hold, departure from the theoretical becoming greater as the conveyor moves from a vertical to a horizontal position. Turning and mixing of the mass as it moves and perhaps centrifugal force and wedging are probable factors, in some relative combination, that cause this departure from the theoretical.

No specific reason can be proposed for the unique shape of the torque curves although percent fill and centrifugal forces are believed to be factors.

Horsepower

The horsepower is, of course, proportional to the product of torque and speed. The hump in the horsepower curves below 300 rpm resulted from the high torque values at the lower speeds (Fig. 7).

Results

The results provide an insight into the relationships and effects of various factors upon screw performance, point out specific factors that can be considered for future detailed study, and suggest possibilities for improving performance as follows:

1 Would an axially corrugated or fluted tube reduce turning of the grain mass and thus increase capacity?

2 Would a cylindrical lip fastened to the edge of the feed screw reduce the centrifugal effect on the inflowing grain and thus permit increased capacity?

3 Would a short horizontal feed conveyor be practical? Many manufacturers and consultants use this device.

4 Is there an optimum pitch for the screw used in this type of conveyor?

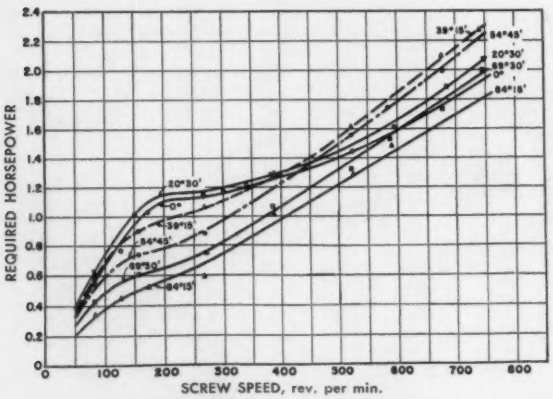


Fig. 7 Horsepower versus screw speed

References

1 Miller, W. F. and G. E. Rehkugler. Capacities and horsepower requirements of four and six-inch auger conveyors. Unpublished paper presented at the ASAE winter meeting, 1957.

2 Rudd, John K. Flow of solids in bins, Sugar 49(6):38-40, 1954.

3 Whited, Willis. The flow of semi-fluids through orifices, Western Penn. Proceedings 17:113-129, 1901.

Nominations for 1960 ASAE Medal Awards

IN accord with the rules governing the award of the John Deere and Cyrus Hall McCormick Gold Medals, the Jury of Awards of the American Society of Agricultural Engineers will receive from members of the Society, up to November 1, nomination of candidates for the 1960 awards of those two medals.

Members of the Society nominating candidates for either award are requested to keep in mind the purposes of each medal and make their nomination accordingly. The John Deere Medal is awarded for "distinguished achievement in the application of science and art to the soil," which citation is interpreted to cover more than a mechanistic concept of engineering, and to include chemistry, physics, biology, and any other science and art involving the soil, the "application" being acceptable to evaluation by the engineering criteria of practicality and economic advantage.

The Cyrus Hall McCormick Medal is awarded "for exceptional and meritorious engineering achievement in agriculture." Selections for the award may be in recognition of a single item of engineering achievement, but is more likely to be on the basis of the aggregate of weighted accomplishment through a continuing career.

The Jury of Awards desires that members of the Society consider it their duty and obligation to give serious thought to the matter and nominate for either or each of these awards the men they believe to be most worthy of the honor. Each nomination must be accompanied by a statement of the reasons for nominating a candidate and qualifications of the nominee, including his training, experience, contributions to the field of agriculture, a bibliography of his published writings, and any further information which might be useful to the Jury in its deliberations.

The Jury will accept and consider nominations received on or before November 1, and these nominations should be addressed directly to the Executive Secretary of the Society at St. Joseph, Michigan. The Executive Secretary will supply on request a standard set of instructions for preparing information in support of nominees for the Society's gold medal awards; in fact, it is important that these instructions be followed in preparing material on behalf of any nominee.

Power Requirements for Combining Solid and Hollow-Stemmed Wheat

F. W. Bigsby

Comparative Tests Indicate More Power Is Needed to Thresh Solid-Stemmed Varieties

THE severe losses in wheat yield in Western Canada caused by the wheat stem sawfly, *Cephus cinctus* Nort., resulted in the development of solid stem varieties of hard spring wheat as a means of combating this insect. These varieties are now commonly grown in regions classified by the advisory councils on grain crops as sawfly areas.

Sometime after the solid stem varieties were introduced it was reported by farmers that the power requirements for combining appeared to be higher than that required to harvest hollow stem wheat. This was apparent with straight combining and was particularly noticeable when picking up windrowed grain, and usually meant that a slower speed of travel was necessary.

The tests reported here were undertaken at the experimental farm at Swift Current, Sask., in 1957 for the purpose of checking the reports and to determine if a difference in horsepower requirement did exist. It was assumed that, if more horsepower was required to harvest solid stem varieties, then it would be most apparent at the combine cylinder, and on this basis only the cylinder horsepower requirement was measured. The common practice on the Canadian prairies is to swath or windrow cereal grain so the tests were confined to crops handled in this manner.

Equipment and Instrumentation

The combine chosen for these tests was a Minneapolis-Moline Model S self-propelled harvester fitted with a short pickup table. Electric resistance strain gages were used to determine the torque on the cylinder shaft, four SR4 type C7 gages being mounted between the bearing and the drive sprocket at 45 deg to the axis of the shaft. The four gages were connected to form the four arms of a bridge circuit and the leads from the four corners of the bridge brought to end of the shaft through an axial hole. These leads were then connected to a mercury collector unit. Fig. 1 shows the covered gages and the collector unit mounted on the combine.

The collector unit was constructed from two plastic blocks, which were cast to the required size from a cold-setting liquid plastic sold under the trade name "Plasticast." The blocks were milled smooth and square and one-half of each cell was milled in each block. A brass ring around the outer edge of each cell formed the stationary contact. A terminal bolt leading to the outside of the plastic block was brazed to each ring.

The shaft was made from a steel tube covered with plastic tubing which formed the necessary insulation between the shaft and the disks. The disks were machined from brass stock and pressed over the plastic tubing, and the shaft assembly fitted with ball bearings. Lead wires coming through the center of the shaft were fastened to the disks with setscrews. Prior to operation each cell was partially filled with mercury to provide an electrical connection between the disks and the outer ring. A section view of the plastic body and shaft assembly is shown in Fig. 2 and the disassembled unit is shown in Fig. 3.

A Brush Model BL 520 universal amplifier and a Brush Model BL 276 oscillograph were used to amplify and record the signal from the strain gage bridge.

Procedure

The combine cylinder shaft was calibrated by applying a series of known torques and recording the deflections of the oscillograph pen. These data were used to calculate a relationship between torque and deflection.

During the field tests the amplifier and oscillograph were mounted on top of the combine. A portable power unit mounted on a bracket on the side of the combine was used to provide power for the amplifier and oscillograph. Fig. 4 shows the instruments mounted on the combine.

Two plots, one *Triticum aestivum* L., var Chinook, representing the solid-stemmed type, the other *Triticum aestivum* L., var Thatcher, representing the hollow-stemmed type were sown adjacent to each other. In order to determine the ratio between grain and unthreshed material for each of the types of wheat, samples were taken from each of the plots and threshed in a plot thresher. The field tests were made on 12-ft windrows approximately 1,000 ft long cut from these plots. The rate of threshing was determined by timing the runs and weighing the grain threshed during each run.

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Santa Barbara, California, June, 1958, on a program arranged by the Power and Machinery Division.

The author — F. W. Bigsby — is a member of the research staff, Department of Agriculture, Swift Current, Sask., Canada.

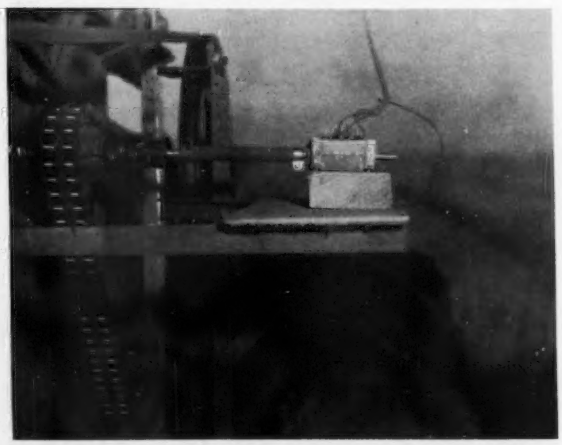


Fig. 1 Covered gages and collector unit mounted on the combine

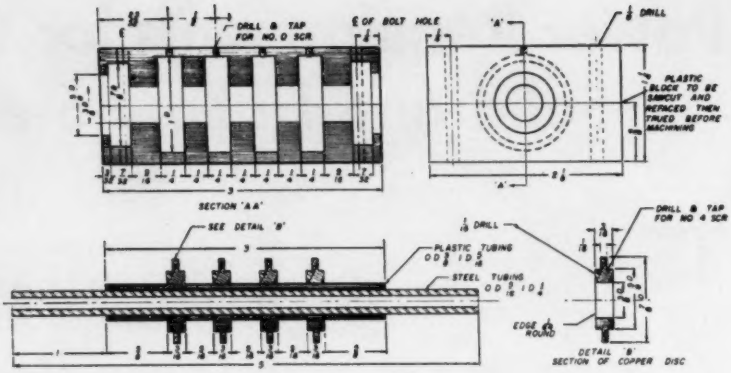

DRILL & TAP FOR NO. 0 SCR
℄ OF BOLT HOLE
'A'
DRILL
PLASTIC BLOCK TO BE SAWCUT AND RETRACED THEN TRACED BEFORE MACHINING
SECTION 'A-A'
SEE DETAIL 'B'
PLASTIC TUBING O.D. I.D.
STEEL TUBING O.D. I.D.
DRILL & TAP FOR NO 4 SCR
EDGE ROUND
DETAIL 'B' SECTION OF COPPER DISC

Fig. 2 Section drawing of collector unit body and shaft assembly

It was originally intended that the event marker on the oscillograph be used to determine cylinder speed; however, the arrangement used to make and break the event marker circuit did not operate satisfactorily. Time did not permit remodelling the event marker system so a tachometer was used to measure the cylinder speed. Readings were taken at intervals during the run and the average speed was used to calculate the power. It was felt that because of the difficulty in keeping the chart speed constant the use of a tachometer was as accurate as the event marker.

The oscillograph chart speed has to be in the order of 50 mm per second in order to get a suitable trace. Allowing the oscillograph to operate continuously during a run would have resulted in excessive chart; therefore, the oscillograph was turned on and off at random until about six feet of chart were obtained.

The average torque required in each run was computed from the average height of the trace. The average horsepower required was computed from the data on average torque and average speed.

Eight runs were made, five on solid stemmed wheat and three on hollow stemmed wheat.

Results and Discussion

Fig. 5 shows horsepower requirements for the various runs plotted against rate of threshing. These results indicate that 20 to 25 percent more power is required on the cylinder when threshing solid-stemmed wheat than is required to thresh hollow-stemmed wheat at the same rate. One possible reason for this difference was that there was more straw for a given amount of grain in the solid-stemmed variety. For the hollow-stemmed variety the ratio between straw and unthreshed material was 1 : 1.80, and for the solid-stemmed variety the ratio was 1 : 1.92. This information indicates that the difference in weight is not great enough to account for the difference in power required for the two types of wheat.

The extra power required for the solid-stemmed variety could be accounted for, if it were assumed that power was absorbed in crushing the straw as it passed through the cylinder. This assumption is substantiated by the fact that the cylinder torque traces show much more frequent and higher peaks when threshing a solid-stemmed variety than when threshing a hollow-stemmed variety. The high and frequent peaks occurring when threshing a solid-stemmed variety show that the torque requirement is much more sensitive to changes in density of the solid-stemmed windrow. Since all windrows were made with the same machine variations in windrow density should be approximately the same for both varieties. Larger variations in torque for similar variations in windrow density are probably caused by the fact that the variety showing the larger variations was less resilient.

Fig. 6 compares the traces obtained when threshing the two types of wheat at approximately the same rate. The figure also shows the percent of time during which the

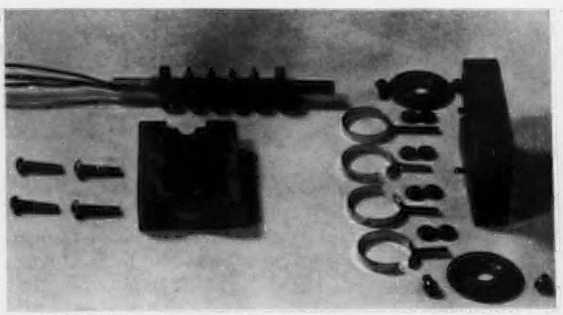


Fig. 3 Disassembled collector unit

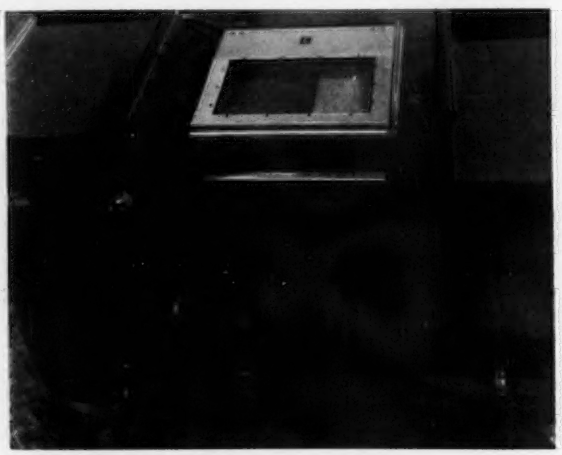


Fig. 4 Amplifying and recording instruments mounted on the combine

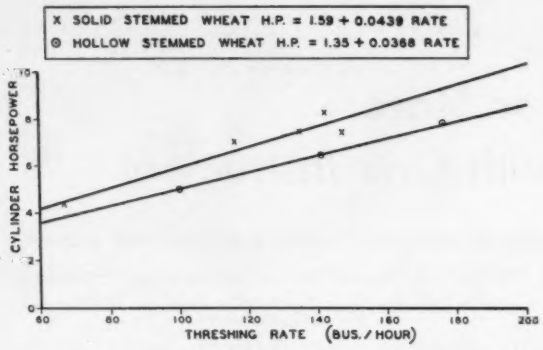

X SOLID STEMMED WHEAT H.P. = 1.59 + 0.0439 RATE
⊙ HOLLOW STEMMED WHEAT H.P. = 1.35 + 0.0368 RATE
CYLINDER HORSEPOWER
THRESHING RATE (BUS./HOUR)
COMPARISON OF POWER REQUIRED AT THE CYLINDER TO THRESH SOLID AND HOLLOW STEMMED WHEAT.

Fig. 5 Horsepower requirements to thresh hollow and solid-stemmed wheat

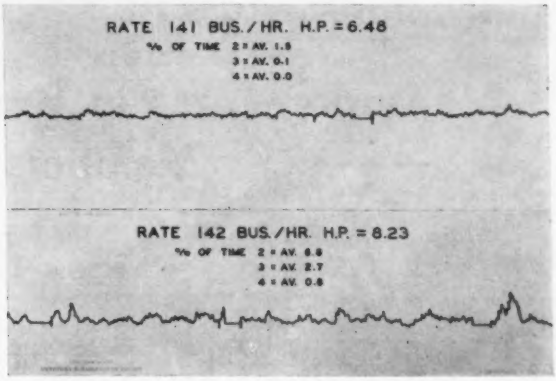


Fig. 6 Comparison of charts obtained when threshing hollow-stemmed wheat *(upper)* and solid-stemmed wheat *(lower)*

torque on the cylinder was equal to or greater than the stated multiples of the average. It should be noted that while threshing the solid-stemmed variety the torque on the cylinder was equal to or greater than four times the average for almost one percent of the time, while the torque on the cylinder when threshing the hollow-stemmed variety did not reach four times the average at any time.

As long as none of the peaks persist, the engine can maintain speed and clear the cylinder. No data are available on the length of time a peak can persist without stalling the engine. However, observations during the tests indicated that if the peak did not persist for more than one-tenth of a second the engine would not stall.

Conclusion

These tests verify reports that more power is required to thresh solid-stemmed varieties of wheat than is required to thresh hollow-stemmed varieties. It can be expected that this power difference would be more apparent with hollow-stemmed varieties which have weaker stems, such as Apex and Marquis.

The information obtained from these tests would be of use when choosing a combine-windrower combination or when choosing the correct size header table for a given combine. The tests show that a given combine should be used in conjunction with a windrower approximately 20 percent narrower when harvesting a solid-stemmed variety.

The rate of threshing can be controlled satisfactorily by changing the combine ground speed when straight combining but when picking up windrows this procedure does not give good results.

Firmly settled windrows have a tendency to pull into the combine in bunches. This is caused by the fact that the feeder speed does not change with ground speed and bunches are not reduced before they hit the cylinder. In practice it is almost impossible to feed the combine evenly when picking up a heavy windrow. Much more satisfactory operation can be achieved by reducing the size of the windrow to the point where the combine can handle the windrow at a fairly high speed.

The author feels that further tests should be conducted to investigate the effect of combine cylinder and feeder design on the magnitude of the peaks observed in the torque curve. Although the maximum average horsepower observed in these tests was only of the order of one-fifth of the power available, it was not possible to load the combine further without danger of stalling the engine. If changes in cylinder design would reduce the peaks, it would be possible to fit the combine with a much smaller engine and thereby reduce the cost of a combine.

Nominations for 1960 MBMA Award

ASAE Members are invited to nominate qualified candidates for the MBMA Award for the year 1960.

This award made available by the Metal Building Manufacturers Association and accepted in 1958 by the ASAE Council for administration by the Society, was first awarded in June 1959 to Theodore E. Bond. Its purpose is to recognize and honor young engineers "For distinguished work in advancing the knowledge and science of farm buildings."

Features of the award include (a) an engrossed diploma citing the achievement or service on which the award is based, (b) a presentation watch, and (c) to the school from which the recipient received his bachelor's degree, a plaque "in recognition of its contribution to the preparation of (the recipient) for outstanding achievement."

Any member of the Society in any grade may nominate a qualified candidate for consideration for the award. Additional members may support the nominating petition by signature.

To be eligible for consideration by the Jury, a nominee must be an ASAE member in good standing under 45 years of age at the time the nomination is received at ASAE headquarters. There are no other limitations to eligibility for consideration. Nominations for the 1960 award should reach ASAE headquarters on or before November 1, 1959.

Further instructions will be furnished by ASAE headquarters, on request, to any member interested in submitting a nomination.

Correction

THE authors of the article, "Development of a Fruit and Nut Harvester" which appeared in the July issue of AGRICULTURAL ENGINEERING, wish to acknowledge the assistance of Allan A. McKillop, assistant professor and assistant agricultural engineer, University of California, Davis, in the development of the new pickup principle discussed in the article.

Measuring Force in Two or More Members with One Instrument

Alfred L. Neuhoff
Assoc. Member ASAE

The technique of using one strain analyzer and recorder to measure the sum of two or more forces simultaneously

THE use of SR-4 electrical resistance strain gages is normally to determine the strain (elongation of the material in inches per inch) or the stress in a member due to an imposed load. Another important application of SR-4 gages is to determine certain forces for the purpose of establishing power requirements, bearing loads, etc. The technique described in this paper shows how one can use one strain analyzer and recorder to measure the sum of two or more forces simultaneously by connecting the members electrically instead of measuring each force separately and then adding the forces together. This has the advantage of reducing the equipment to accomplish a given job and reduces the time required to analyze the data.

Assume that it is desired to determine the power requirements for plowing with a mounted moldboard plow on the conventional 3-point linkage on modern farm tractors. The depth of plowing can be determined by direct measurement or with strain gages on a depth-indicating gage-wheel mechanism. The speed can best be determined by accurate timing over a specified test distance. The only missing item then is the forces in the draft arms and top compression link. The two draft links normally can sustain both axial and bending forces due to the members that connect them to the hydraulic rams or rocker arm assembly that serve to raise or lower the arms, even though the ends are normally mounted on ball swivel joints. This makes it necessary to measure both types of forces in these links.

An Instrument News Contribution. Articles on agricultural applications of instruments and controls and related problems are invited by the ASAE Committee on Instrumentation and Controls, and should be submitted direct to Karl H. Norris, instrument news editor, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The author — ALFRED L. NEUHOFF — is supervisor of quality control, Rockford Works, J. I. Case Company.

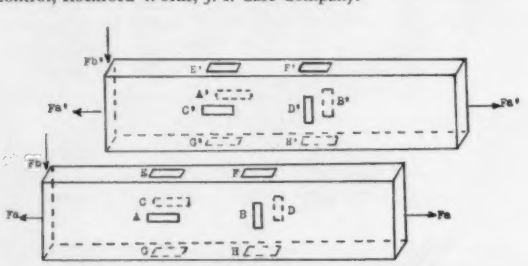


Fig. 1 Sketch of gage arrangement on draft arms

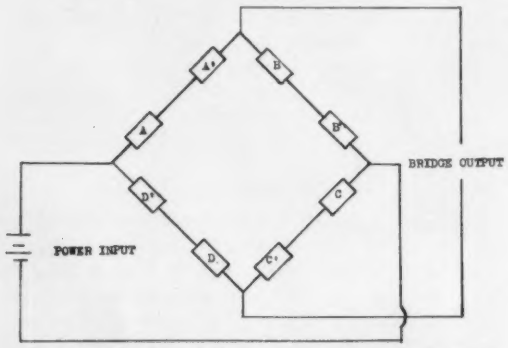


Fig. 2 Bridge circuit of gages on draft arms to measure Fa and Fa', simultaneously

Instrumentation

By mounting gages on the draft arms as shown in Fig. 1, one circuit will suffice to measure the resultant axial force and another circuit will serve to measure the resultant bending forces.

Gages A, A', C, and C' are so oriented that grids are sensitive to Fa and Fa' and insensitive to Fb and Fb' as they are located opposite each other on the theoretical neutral axis. Gages B, B', D, and D' are insensitive to either Fa or Fa' and Fb or Fb' as they are oriented normal to the neutral axis and centered over it directly opposite one another as shown. Any axial forces in the draft arms can then be measured with the gages connected in a Wheatstone bridge arrangement as shown in Fig. 2. Any bending forces, Fb or Fb', will not affect the bridge balance. Gages E, E', F, F', G, G', H, and H' are all strained an equal amount by the axial forces Fa and Fa', and therefore the Wheatstone bridge shown in Fig. 3 will not be affected by them. Any force Fb or Fb', however, will cause gages E, E', F and F' to have opposite strains of gages G, G', H, and H' and will therefore be sensitive to bending forces only. It

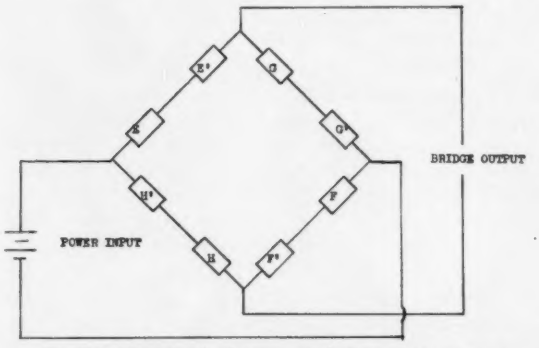


Fig. 3 Bridge circuit of gages on draft arms to measure Fb and Fb' simultaneously

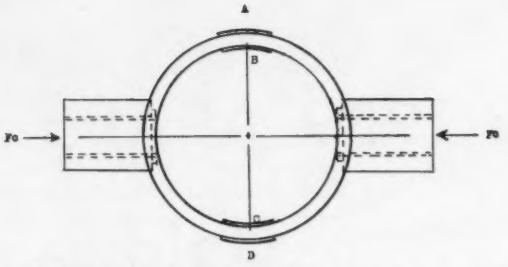


Fig. 4 Sketch of gage arrangement on proving ring to replace turnbuckle in top link

can be shown that, since we will be working with strains well within the elastic limit of the material, the bridges shown in Fig. 2 and 3 will measure the resultant or added forces (Fa and Fa') or (Fb and Fb') when so calibrated. This data will give all of the forces in the draft arms affecting draft, weight transfer, or power required for this plowing operation with two strain analyzers. It is pointed out that while Fig. 1 is only diagrammatic and does not show that the horizontal location of corresponding gages are the same, this is necessary so that a given force Fb or Fb' will cause a like strain in the draft arms.

It should be noted that gages A and A' and gages C and C' are positioned in such a way that should a lateral force exist, such as might occur when striking a rock, the resultant force will not be affected by such a force. This is made possible by providing a rigid link between the draft arms so that a lateral force will cause the two links to move together producing tension in gage A and C' and compression in gage A' and C, or vice versa, with no result on the bridge balance. One requirement for the system to function satisfactorily is that the cross section of the two draft arms be equal at the point where the gages are applied. Strain gage theory and the operation of a simple Wheatstone bridge show that the above described system will satisfactorily measure the resultant axial and bending forces with two instruments where normally four instruments are required.

The top link is primarily a compression link while operating a plow or other implement. It can contain bending forces due to friction in the ball swivel joints, eccentricity, and due to the weight of the link itself. Though bending forces in this link are small, greater overall accuracy can be obtained by replacing the conventional turnbuckle with a strain-gage-equipped proving ring as shown in Fig. 4 and connecting the gages as shown in Fig. 5.

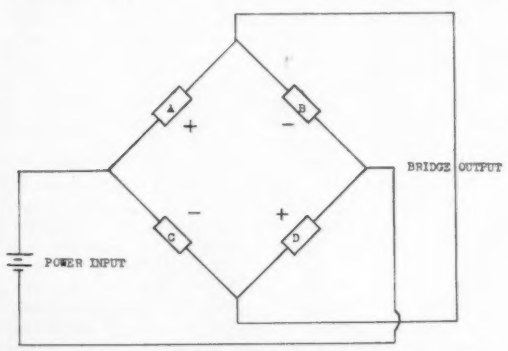


Fig. 5 Sketch of bridge circuit of gages on proving ring sensitive to axial forces only

Any compressive force, Fc, will cause gages A and D to be in tension and gages B and C to be in compression, resulting in a very sensitive unbalance of the Wheatstone bridge. Bending forces will cause gages A and B to have like strains, while gages C and D will have opposite strains with no effect on the bridge balance so long as the amount of strain in gages A and B and in gages C and D is equal. This was verified by the application of a large bending moment on the member with no effect on the bridge balance. This allows the complete force analysis to be made with three strain analyzers instead of five.

Discussion

To determine the resultant pull of the implement, weight transfer to the tractor's rear wheels and rear-wheel loading, one can determine the angle of the draft arms and top link with respect to the direction of travel for any plowing depth and then treat the tractor as a free body in equilibrium summing moments about the rear wheels. This reveals how a given operation affects the rear-wheel loading on a tractor as well as the draft or power requirements.

While this paper deals with a specific example, this technique can be successfully used to measure resultant-like forces in two or more like members simultaneously or even to measure combined torques in two shafts of the same size simultaneously. While the principles used are common, this technique allows one to accomplish some jobs with less equipment or allows one to measure more forces at the same time with a given amount of equipment. This has merit especially when one is trying to correlate one factor with another, or when one wishes to get all the necessary information at the same time rather than making two or more test runs and having to assume that the conditions do not change.

Going Metric

AT its December 1957 Meeting, the Council of American Association for the Advancement of Science adopted a resolution approving in principle the general adoption of the metric system of weights and measures and appointed a committee to make a study of the most economic and feasible method of changing over to metric usage, and also agreed to cooperate with the British Association in efforts to further this objective. At its December 1958 meeting the AAAS committee on metric usage presented a progress report and will continue its studies. The British Association committee will submit its report at its September 1959 meeting of that association.

In view of the complexity and some confusion in existing units of measurement, both in the United States and abroad, and in an effort to ameliorate this situation, Section M-Engineering held a four-session meeting on National and International Aspects of Systems of Units during the December 1958 meeting of AAAS in Washington. Twenty-eight leaders of industry, education, and government from six countries participated. The proceedings will be published as a Symposium volume. A second series of sessions on this same general subject is planned for the December 1959 AAAS meeting in Chicago.

FLOYD W. DUFFEE

The 1959 ASAE Gold Medalists

Cyrus Hall McCormick Medal was awarded to Floyd W. Duffee

SELECTION of the recipient of the Cyrus Hall McCormick Gold Medal award for 1959 goes to a man to whom friends and colleagues generally would accord top rating as a rugged individualist, but withal a man greatly admired and respected by those who know and have been associated with him. It honors one who has given forty years of invaluable engineering service to the agriculture of his state and the nation—a man as much at home in dealing with practical farm matters as in seeking solutions of tough engineering problems in a university laboratory or training budding agricultural engineers in the classroom.

Floyd Waldo Duffee was born on a farm in Wayne County, Indiana, January 21, 1893, the son of Henry Neal and Mary Jane (Newbern) Duffee. Though he was an only child and lost both parents early in life, he has always maintained strong family ties with relatives in his home county. He attended high school there from 1907 to 1911, during which time he owned and directed operation of the family farm. For a year he was a student at Bethany College at Bethany, West Virginia, and in 1912 he entered Ohio State University from which he graduated in 1915 with the degree of bachelor of science in agriculture, including a major in agricultural enginering. The following three years he served as instructor in agricultural engineering at Connecticut Agricultural College, now the University of Connecticut. In 1918 he joined the staff of the agricultural engineering department of the University of Wisconsin, where he has since served successively as instructor and professor. He was appointed chairman of the department in 1937, which position he has since held.

Professor Duffee's reputation as a rugged individualist stands out prominently in his insistence that his graduates be as well trained in the fundamental agricultural sciences as they are in the basic engineering subjects. As a consequence, agricultural engineering graduates of the University of Wisconsin are required to earn the bachelor's degree both in mechanical or civil engineering and in agriculture.

Floyd Duffee's reputation as a teacher and lecturer is at least equalled by that of researcher and development engineer, in which he has gained both national and international reputation. Of primary interest to him has been the development of machinery and methods for the harvesting, processing and storing of crops for dairy cattle. The main lines of farm equipment research in which he has engaged include that of ensilage cutters (1921-25), small feed grinders (1925-30), haymaking machinery (since 1927), grass-seeding equipment (since 1937), and electrical mechanization of the dairy farmstead (since 1945). He has played a leading role in formulating code regulations for electric fence controllers and has served as chairman of both state and national code committees since 1937.

Indeed he has been continuously active in rural electrification development since 1921. In 1945, in cooperation with the state utilities association, he established the Wisconsin Electric Research Farm, which has resulted in bringing about many improvements in the way of planning stall dairy barns and in developing, improving and testing of many farm equipment items in cooperation with the manufacturers.

The phenomenal growth of the hybrid seed-corn business is in no small measure due to the development of a facility with which Mr. Duffee was prominently identified. Faced with the problem of drying seed corn under conditions of the short growing season in Wisconsin, Duffee in 1926-28 in collaboration with Andrew H. Wright, then an agronomist in the college of agriculture, developed the bin-type drier, the first seed corn drier capable of drying a large volume quickly, safely and inexpensively. Today this drier is the foundation of hybrid-seed processing and is in use generally throughout the United States and Canada.

Floyd Duffee was one of a large research team that began studying methods of grass seeding in the 1930's. This group during the fall of 1937 established the importance of shallow seeding and developed and tested (in 1938) the first experimental roller with small corrugations (2 x 1¼ inches) for shallow seeding.

If Engineer Duffee derives more satisfaction from one of his brain children than from another, it could be that of originating the idea of the "forage harvester" (the name he personally coined), and encouraging manufacturers to produce it for the farm market. At the Annual Grassland Farming Contest Roundup in November, 1951, he received formal recognition for his outstanding work in connection with this development. The citation of the award presented to him on that occasion, in addition to crediting him with being primarily responsible for initiating the idea of the forage harvester, also recognized that it was due to his enthusiasm and untiring efforts that the farm implement industry was induced to build and make the forage harvester available to farmers of the nation.

As a researcher and development engineer, Floyd Duffee has faithfully recorded the results of his work in an impressive list of publications which he has authored solely or in collaboration with associates. These include twenty-seven University of Wisconsin publications as follows: four on dairy barns and equipment, three on corn drying, four on grass silage, four on mow hay drying, three on housing farm machinery, two on farm transportation equipment, and seven miscellaneous. Out of a total of forty-seven professional papers he has contributed over a period of twenty-three years to AGRICULTURAL ENGINEERING, the journal of the American Society of Agricultural Engineers, Professor Duffee is sole author of all but one of them. In addition to these technical contributions, he has authored numerous articles for such farm publications as "Country Gentleman," "Capper's Farmer," "Successful Farming," and "Wisconsin Agriculturist and Farmer." He is also author of a book entitled "Farm Gasoline Engines."

Floyd W. Duffee has been a member of the American Society of Agricultural Engineers since 1919, and in recognition of his engineering accomplishments and standing in the profession, he was elected a Fellow of the Society in 1938. His participation in Society affairs has consisted largely of papers of exceptional merit presented at meetings of the Society and subsequently reproduced in its publications. He has also participated in a number of important com-

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The American Society of Agricultural Engineers awards annually the Cyrus Hall McCormick Medal for "Exceptional and Meritorious Engineering Achievement in Agriculture" and the John Deere Medal for "Distinguished Achievement in the Application of Science and Art to the Soil." Presentations of the 1959 Awards were made during the Society's 52nd Anniversary Meeting at Cornell University, Ithaca, N. Y.

See page 462 for details on special MBMA Award.

The John Deere Medal was awarded to Fred R. Jones

FRED R. JONES

IN naming Fred R. Jones to receive the John Deere Gold Medal award for 1959, the jury of awards of the American Society of Agricultural Engineers gives recognition to one of the great teachers and administrators the agricultural engineering profession has produced. This fact stands out in bold relief in the warmth of the commendations of both former students and their employers. One such employer of many of these graduates credits Professor Jones' success as a teacher to his genuine interest in his students and to his constant efforts to develop their capabilities for top performance in their chosen profession.

Fred Rufus Jones was born June 2, 1893, on a farm near Mauston in Juneau County, Wisconsin, the son of Rufus S. and Elizabeth (Klinker) Jones. He attended both rural schools and city schools in Mauston, graduating from the high school in 1911. He entered the University of Wisconsin the same year and graduated with a bachelor of science degree in 1915, being one of the University's first students to major in agricultural engineering. During this four-year period, it is of interest that he earned most of his college expenses working as an assistant to Professor F. B. Morrison on the revision of the latter's classic textbook, "Feeds and Feeding." He later supplemented this basic training at Wisconsin by doing graduate work during the summers of 1927, 1929, and 1930 at Iowa State College, where he was awarded the master of science degree in agricultural engineering in 1931.

Fresh out of college in June 1915, Fred Jones' first job that summer was the assembling and servicing of farm machinery at the Davenport, Iowa, branch of the International Harvester Company. The following September, he returned to the University of Wisconsin to become an instructor in agricultural engineering, where he remained until January 1917, when he resigned to accept an appointment as farm machinery extension specialist at Mississippi State College. Just one year later he entered the employ of the U.S. Department of Agriculture to engage in dust explosion investigations.

This latter employment was terminated six months later when Mr. Jones volunteered to do his bit in World War I. He enlisted in the air service of the U.S. Marine Corps., from which he was later discharged as an airplane pilot with the rank of second lieutenant, having served from June to December, 1918. Following his war service, he was engaged during 1919 on educational and sales work with the Advance-Rumely Thresher Company, and during 1920 he was employed as a sales representative of the John Deere Plow Company at St. Louis, Mo.

Professor Jones' distinguished career as a teacher and department administrator actually got its start with his appointment as an instructor in the agricultural engineering department at the A & M College of Texas in February 1921. His first promotion in the department came when he was advanced to the rank of assistant professor in September 1922. Just five years later he was made an associate professor in the department, and following a span of eight more years, he was made a full professor. In January 1940 he was promoted to the position of professor and head of the agricultural engineering department, which at that time included only the function of resident instruction. However, in November, 1946, following consolidation of all resident instruction, research and extension under the new Texas A & M College System, Professor Jones' duties were expanded to include over-all supervision of research and extension as well as resident instruction, in his department. In 1950 the department and the professional curriculum in agricultural engineering, which it was offering to students, was accredited by the Engineers' Council for Professional Development, and was followed by reaccreditation in 1953 and 1958.

In September 1958 Mr. Jones, having reached the prescribed retirement age, relinquished his connection with the college. During his tenure with the department (1921-58), approximately 700 students were awarded the bachelor of science degree in agricultural engineering and 50 students the master of science degree.

Along with his heavy teaching duties, Mr. Jones found time to author a widely used college textbook, "Farm Gas Engines and Tractors," first published by the McGraw-Hill Book Company in 1932, followed by second and third editions in 1938 and 1952. He is also author of the booklet "Farm Equipment Service," published by W. R. C. Smith Publishing Company, and also co-author of numerous bulletins and articles in farm publications on farm power and machinery.

Fred Jones was admitted to membership in the American Society of Agricultural Engineers in 1917. He was elected a Fellow of the Society in 1938, and in 1949 he was made a Life Member of the Society, having fulfilled the qualifications for that grade of membership. Other professional society memberships include the American Society for Engineering Education and the honorary societies Alpha Zeta, Tau Beta Pi, and Phi Kappi Phi. He is also a registered professional engineer of the state of Texas.

Mr. Jones' participation in ASAE activities include that of chairman of the Southwest Section, member of the Society's Council (1929-32), member of the advisory committee of the College Division (1936-38), vice-chairman and chairman of the College Division (1951-53), general chairman of the arrangements committee for the 1951 annual meeting, member of the ASAE inspection group for EPCD accrediting (1954 to date).

In August of 1922, Fred Jones married Edelweiss Koppe, whose grandfather, Henry Kurten, arrived from Germany about 1860 and established the community of Kurten, Texas, in Brazos County, near Bryan. Mr. and Mrs. Jones reside at 201 College View in Bryan. Among his hobbies and special interests, Fred lists bridge, professional baseball, fishing, automobile and tractor maintenance, and cattle ranching.

Mr. and Mrs. Jones are members of the First Methodist Church of Bryan, of which Fred is a past-chairman of the board of stewards and presently chairman of the building program committee which was responsible for directing the financing, planning and construction of a $600,000 sanctuary and educational building completed in 1955. Mr. Jones is also past worshipful master of Brazos Union Lodge, F&AM, of Bryan, and is a member and president (for 1959-60) of the Bryan Rotary Club.

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HIGH LIGHTS

of 52nd Annual Meeting

CORNELL UNIVERSITY, ITHACA, N. Y.

June 21 to 24, 1959

Orval C. French, head of agricultural engineering department, Cornell University (host for the meeting), spoke in behalf of his staff members in extending a welcome to New York

A total of 1297, including women and children, attended the 52nd Annual Meeting of ASAE held on the beautiful campus of Cornell University located "far above Cayuga's waters." Visitors were impressed by the efficient and friendly manner in which the meeting was conducted and by the scenic beauty of the campus and surrounding countryside. For many the meeting offered an excellent opportunity to combine business with a vacation in the heart of the famous Finger Lakes area.

Preliminary activities started Saturday, June 20, with the Council opening its meeting at 10:00 a.m. in Riley-Robb Hall. Registration began at 1:00 p.m. on Sunday, and a good turn out was on hand for the Sunday evening entertainment which featured a program of Indian costume and lore set up by Dr. E. A. Bates, adviser of Indian Extension.

Meeting Sessions

Five concurrent sessions were held Monday morning including: Joint Soil and Water — Power and Machinery Division (Program A); Power and Machinery Division (Program B); Electric Power and Processing Division; Farm Structures Division; and a special program for the Public Lands and Public Works group. Monday afternoon sessions consisted of the following divisional programs: Electric Power and Processing; Farm Structures; Joint Soil and Water—Public Lands and Public Works group; Power and Machinery—Programs A and B.

Concurrent sessions continued on Tuesday morning, which included divisional programs: Farm Structures; Joint Soil and Water — Public Lands and Public Works group; Joint Power and Machinery — Na-

(Below) Retiring President Dr. E. G. McKibben made formal presentations to gold medalists and special MBMA award winner during the Wednesday evening "President's Party"

C. H. McCORMICK MEDAL

Floyd W. Duffee, head of agricultural engineering, University of Wisconsin, receives Cyrus Hall McCormick Medal

JOHN DEERE MEDAL

Fred R. Jones, former head of agricultural engineering, A & M College of Texas, accepts John Deere Medal

MBMA AWARD

Theodore E. Bond, agricultural engineer, AERD, ARS, USDA, University of California, Davis, becomes first recipient of newly inaugurated Metal Building Manufacturers Association Award

(Right) H. W. Riley, charter member of ASAE, left, and Byron B. Robb, professor emeritus of agricultural engineering, in whose honor Cornell's agricultural engineering building was named, were on hand to greet old friends

(Left) Raymond Olney, former graduate from Cornell, received a standing ovation during the presentation program following the announcement of his retirement from the ASAE staff after 38 years of continuous service

(Left) Byron T. Shaw, Administrator, Agricultural Research Service, USDA, Washington, D.C., was featured speaker during General Session Wednesday afternoon. He discussed the research challenge to agricultural engineering

(Right) Inauguration of the new president followed the presentation of awards on Wednesday evening. Lawrence H. Skromme, chief engineer, New Holland Machine Co., left, accepts the gavel from Retiring President Dr. E. G. McKibben, director of Agricultural Engineering Research Division, Agricultural Research Service, USDA

tional Joint Committee on Fertilizer Application (Program A); Power and Machinery (Program B). The Public Lands and Public Works group held an individual meeting on Tuesday afternoon.

Karl D. Butler *(right)* farm counselor, AVCO Mfg. Co., presented an illustrated account of a tour made by six ASAE members last fall in Russia during the Wednesday evening program. He is shown presenting Dr. McKibben with a gift shirt, reportedly obtained in Russia

Four concurrent sessions on Wednesday morning concluded the divisional meetings. These included; Joint Soil and Water—Public Lands and Public Works group; Power and Machinery—Programs A and B; Joint Farm Structures and Electric Power and Processing.

An Extension Seminar was held on Thursday, with E. D. Markwardt presiding at the morning session and S. P. Lyle at the afternoon session.

Business Meeting

C. W. Terry, chairman of the meetings committee, presided at the General Session, Wednesday afternoon. Presentation of the winning student paper, "A Proposed Reversing Clutch and Control System for Self-Propelled Windrower," was made by R. P. Gehman, Pennsylvania State University. Byron T. Shaw, administrator, Agricultural Research Service, USDA, Washington, D. C., spoke on "The Research Challenge to Agricultural Engineering." The president's annual address, by E. G. McKibben, which followed, was entitled "Engineering in Agriculture." See page 385, July issue, for complete address.

Special Activities

The buffet dinner and entertainment on Sunday evening proved to be a very fine beginning for the 52nd Annual Meeting. Organized tours and special events were well attended and included the ladies' and children's special program. Tours on Tuesday afternoon included the Corning Glass Center, home of the world-famed Steuben Glass; the Morse Chain Co., which plays a large part in the production of agricultural machinery and equipment; and the well-known Ithaca Gun Co. The student section enjoyed an early morning breakfast on Monday, and also the FEI student dinner on Tuesday evening. The barbecue dinner, scheduled for Monday evening at Taughannock State Park, was rained out and rescheduled for Barton Field Auditorium. This change in plans made the chicken none-the-less delicious.

Special Awards and Entertainment Program

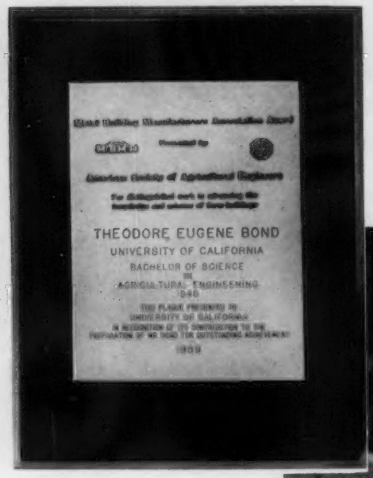
A departure from the usual Annual Dinner was made this year, which was replaced with a Special Awards and Entertainment Program. This program was presented on Wednesday evening, with J. F. McManus, assistant dean, College of Engineering, Cornell University, as master of ceremonies. Dr. E. G. McKibben, president of ASAE, presented the following awards: Floyd W. Duffee, head, agricultural engineering department, University of Wisconsin, the Cyrus Hall McCormick Medal; Fred R.

(Continued on page 462)

FEI STUDENT DINNER

Presentation of FEI Trophy Awards were made during FEI Student Dinner Tuesday evening, sponsored by the Farm Equipment Institute. *(Left)* Left to right, F. P. Hanson, Caterpillar Tractor Co., served as master of ceremonies; A. M. Best, New Holland Machine Co., introduced featured speaker; E. L. Barger, Massey-Ferguson, Ltd., gave an illustrated talk on recent world travels; and D. M. Daubert, J. I. Case Co., and chairman of ASAE committee on FEI trophies, presented the awards • *(Right)* Trophy winners were, left to right, Richard C. Fluck, North Carolina State College; John C. McCornack, Oklahoma State University; Vincent V. Salomonson, Colorado State University (Class B Winner); Joe L. Hood, University of Georgia (Class A Winner); Finis Schultz, University of Illinois; and Donald K. McCool, University of Missouri

MBMA Award Winner



Theodore E. Bond has been selected as the first recipient of the new award for "distinguished work in advancing the knowledge and science of farm buildings" recently established by the Metal Building Manufacturers Association and administered by ASAE. In recognition of his personal achievement Mr. Bond received a certificate and an engraved watch.

T. E. Bond, winner of first MBMA Award, is shown with appropriately engraved plaque presented to the institution from which he received his B.S. degree

Presentation was made during the 52nd Annual Meeting of ASAE, June 24, at Cornell University, Ithaca, N. Y. An engraved plaque, presented to the institution from which the winner received his bachelor's degree, was received by the University of California. It will be displayed permanently in the Harry B. Walker Engineering Building on the Davis campus.

The winner was born at Tawanda, Kans., in 1917, attending high school and one year of college in Manhattan, Kans. In 1948 he graduated from the University of California with a B.S. degree in mechanical engineering with an agricultural engineering option. In 1951 he earned an M.S. degree in agricultural engineering with a minor in civil engineering from Iowa State College. He was inducted into the U.S. Army in 1943 and served overseas in Italy with the 4th Corps Headquarters Engineers Section. Since 1948 he has been associated with what is now the livestock engineering and farm structures research branch of the Agricultural Engineering Research Division of USDA, at the University of California.

He has collaborated with C. F. Kelly, also an agricultural engineer at Davis, in improving swine and cattle shelters for California conditions. He has been specifically cited for his application of research methods to measure the influence of environmental factors on livestock production and by interpreting the results in the functional design of livestock shelters.

High Lights of 52nd Annual Meeting

(Continued from page 461)

Jones, retired head of the agricultural engineering department, A. and M. College of Texas, the John Deere Medal; and Theodore E. Bond, agricultural engineer, U.S. Department of Agriculture, the Metal Building Manufacturers Assn. Award. Following the awards presentation, L. H. Skromme, chief engineer, new Holland Machine Co., was inaugurated as the new ASAE president. The evening's entertainment was provided by the Genesee Chapter Chorus, singing many of the "old favorites".

Student Activities

The following officers were elected to serve on the National Council of ASAE Student Branches for 1959-60: President, Earl E. Evans, University of Illinois; first vice-president, Richard C. Fluck, North Carolina State College; second vice-president, George A. Duncan, University of Kentucky; and secretary, Cliffton A. Maguire, Iowa State University. The FEI Student dinner was held Tuesday evening in Willard Straight Hall, Elmhurst Room. E. L. Barger, manager, product planning and education, Massey-Ferguson Ltd., Canada, related experiences and showed slides concerning farm equipment developments on a recent world tour.

Group A winner of the Farm Equipment Institute trophy award was presented for the fourth consecutive year to the Georgia Student Branch; honorable mention for this group going to Illinois and Missouri Student Branches. The Colorado Student Branch received honors as winner in the B Group, with honorable mention given to Oklahoma and North Carolina Student Branches.

These trophies were presented to two student branch groups (Group A included the larger branches and Group B the smaller ones) in recognition of outstanding initiative and accomplishment in ASAE Student Branch activities. Awards were made by D. H. Daubert, chairman, Committee on FEI Trophies.

First place award in the student paper contest was presented to Roland P. Gehman of Pennsylvania State University. His manuscript entitled "A Proposed Reversing Clutch and Control System for Self-Propelled Windrower" was presented during the annual business meeting. Second place winner, Merwin D. Beckwith of Michigan State University, presented a paper entitled "The Behavior of Liquid in a Simulated Tractor Tire." Donald C. Anderson, Kansas State College, was third place winner. His subject was "Separation of Grain by Projection into Still Air with a Grain Spectrometer."

ASAE MEETINGS CALENDAR

August 23-25—North Carolina Section, Camp Swannanoa, Swannanoa, N. C.

September 1-3 — North Atlantic Section, University of Maryland, College Park, Md.

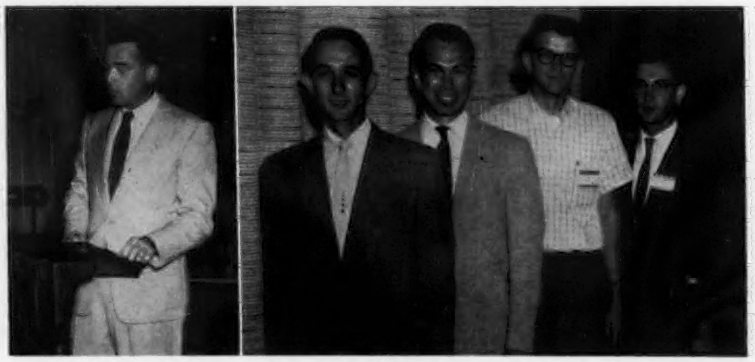
October 2-3 — Kentucky Section, Mammoth Cave, Ky.

October 9-10 — Tennessee Section, University of Tennessee, Knoxville.

October 12 — Ohio Section, Agricultural Experiment Station, Wooster, Ohio

October 14-17 — Pacific Northwest Section, Ephrata, Wash.

Note: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.



***(Left)* Roland P. Gehman, Pennsylvania State University, presented the winning student paper during the General Session of the ASAE 52nd Annual Meeting at Cornell University, June 24 • *(Right)* Officers elected for the National Council of Student Branches are, left to right, George A. Duncan, University of Kentucky, 2nd vice-president; Cliffton A. Maquire, Iowa State University, secretary; Richard C. Fluck, North Carolina State College, 1st vice-president; Earl E. Evans, University of Illinois, president**

NEW **McCORMICK NO. 15 FIELD HARVESTER**

Here's big chopping capacity at a price that matches the lowest on the market! This low-price No. 15 can fill the new 5 to 6-ton McCormick No. 61 Power-Unloading Box in less than 10 minutes!

Chops with the biggest... priced with the lowest!

Here's the leading flywheel-type field harvester—the big McCormick No. 36! It chops over 45 tons of corn silage per hour. Pto or engine drive.

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S. C. Partridge

R. K. McConkey

W. E. McCoy

F. M. Potgieter

Hans Sack

Mason Vaugh

R. B. Hickok

E. A. Johnson

Three ASAE members have been included in recent promotions by The Timken Roller Bearing Co.

S. C. Partridge has been promoted from general manager, Industrial Division to director of sales, International Divisions. He earned a B.S. degree from McGill University, Ontario, Canada, in 1925. In this same year he started with the company in the carburizing department of the factory. Prior to his position as general manager, Industrial Division, Mr. Partridge has been successively an industrial sales trainee; Buffalo district manager, Industrial Division; manager of Timken Roller Bearing Co. Service and Sales Co. in Toronto; district manager, Automotive Division in Detroit; and assistant general manager, Industrial Division.

R. K. McConkey has been promoted to the position of general manager of the Industrial Division. He started with the company in 1935, and was assigned to its Milwaukee office in 1937 as a sales engineer. He was then successively the Industrial Division's Los Angeles district manager, Milwaukee district manager, and Moline, Ill., district manager, before he was named assistant general manager of the division in 1953, the post he held until his recent promotion.

Wyn E. McCoy, who started with The Timken Roller Bearing Co. in 1940 as a sales trainee, has been promoted to the position of assistant general manager of the Industrial Division. He has been successively a sales engineer, Chicago district manager of the Industrial Division, and Sales promotion manager for the company.

Fred M. Potgieter, consulting engineer, has been appointed consultant for the manufacture and sales of universal joints for Chain Belt Co. Since 1957 he has been engaged in consultant work and maintained his own office in Rockford, Ill. Mr. Potgieter received a B.S. degree in engineering from the University of Iowa in 1922, after which he became a hydraulics engineer for the Utilities Power and Light Corp. in Chicago. From 1934 to 1938, he was vice-president and chief engineer for Universal Gear Corp. He is also a former vice-president of the Mechanics Universal Joint Division of Borg-Warner Corp., joining the division in 1938 and holding the position of vice-president from 1946 to 1957.

Hans Sack, a member of the ASAE since 1931, was recently honored by the technical university in Munich (West Germany), which has conferred upon him the title of "Honorary Doctor of Engineering" in special recognition of his accomplishments in the "development of new methods of soil processing, pest control, and harvesting of ground crops," all accomplished by mechanical means.

A descendant of a family of pioneers in the development of agricultural machinery, Hans Sack as inventor, researcher, designer, and industrialist played a prominent part in the growth of the firm of Rud. Sack originally founded in 1863. When his generation took over management of the company after World War I, it faced the great task of conversion from horse-drawn to motorized agricultural equipment. His many accomplishments in improving existing models of equipment, as well as in the development of entirely new concepts of methods and machines to meet new and more exacting requirements in agricultural production, bear evidence of the exceptional genius and ability of this pioneering engineer.

In 1939, Dr. Sack resigned as technical director of the firm of Rud. Sack and established his own company in Leipzig under the name: "Dr.-Ing. Hans Sack, Construction of Special Farm Machinery." The outbreak of World War II, however, interrupted the development and expansion of this new company, and it was not until 1951 that he was able to resume his manifold activities in the development of agricultural machinery with a manufacturer in Essen. In 1953 Dr. Sack was signally honored by the Max Eyth Gesellshaft (German counterpart of the ASAE) with the award of the Max Eyth Medal established by that organization. Meanwhile he was offered and accepted the position of professor and director of farm machinery and machine design at the technical university at Aachen.

The recent honor conferred upon this distinguished agricultural engineer, as noted above, is well-earned recognition of a career of outstanding accomplishment in developing the tools made necessary in the rapid transition of agricultural production from a muscle-power to a mechanical-power economy.

Mason Vaugh, life member of ASAE, retired recently as a missionary of the Presbyterian Church, after being associated with mission work in India for the past 38 years. He obtained his advanced education from the University of Missouri where he earned a B.S. degree in agriculture and one in agricultural engineering. His first employment after graduation in 1921 was with the Allahabad Agricultural Institute where he organized the first degree course in agricultural engineering in India. For many years he served as head of the department, and after his retirement a few years ago he has spent full time in operating and developing an implement factory for the production of small plows especially suited to Indian agriculture. In 1957, he retired from his position as professor of agricultural engineering at the Institute, and in 1958 accepted an assignment as executive secretary of the Laymen's Committee on Economic Life and Worldwide Christian Community. Mr. Vaugh also received the Missouri Honor Award for Distinguished Service in Engineering and Engineering Foundation from the University of Missouri in 1958. Although he will be retired officially, he expects to continue some experimental work and also to continue as technical adviser to the implement factory. He will make his home in Wooster, Ohio.

R. B. Hickok advises that he has joined with two former associates in organizing the Facilities Development Planning Corp. in Los Angeles, Calif. They plan to carry on planning and management consulting work on defense projects and also for civil works and industrial facilities. Prior to his new venture, he was associated with Holmes & Narver, Inc., Engineers and Constructors, as a project engineer on site selection and master planning. He had been in soil and water work for 23 years with the U.S. Department of Agriculture, until 1956, when he accepted the position with Holmes & Narver.

E. A. Johnson recently has joined the staff of the College of Agriculture, University of Massachusetts, as instructor in the food engineering phase of the agricultural engineering program. He will be doing teaching and research. He formerly was with the Farm Electrification Laboratory, USDA, Purdue University at Lafayette, Ind.

John W. Wolfe, of the agricultural engineering department staff, Oregon State College, Corvallis, received a Ph.D. degree in Irrigation Science from Utah State University in June of this year. His Doctor's dissertation was titled "The Development and Evaluation of a Method for the Condensation of Moisture Uniformly in Soil without Exceeding Field Capacity."

New steels are born at Armco

Armco ZINCGRIP PAINTGRIP Steel fence charger case below withstood 17 years of continuous atmospheric exposure with no indication of rusting. At right is a complete charger just before painting.

Still No Rust After 17 Years' Continuous Exposure

The fence charger shown at left was in continuous outdoor service in a midwestern rural area more than 17 years, yet the Armco ZINCGRIP® PAINTGRIP® Steel case still shows no indication of rusting. Dark splotches are what's left of the original paint that finally weathered away after many years' exposure to sun and rain.

"This is typical of the service life these cases are providing our customers," says an official of the Parker-McCrory Manufacturing Company, Kansas City, Missouri. The company used its first ZINCGRIP PAINTGRIP back in 1940, and has since standardized on this special steel for its complete line of fence chargers.

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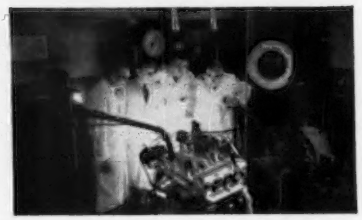

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. . . Medalists

Floyd W. Duffee

(Continued from page 458)

mittee activities. In 1929 he was elected First Vice-President of the ASAE and served the regular term in that office.

His non-professional activities include membership in the Christian Church. He is a Freemason and was active in the work of the Consistory for several years. He is a member of Alpha Gamma Rho college fraternity and in the period of 1935-37 he served as faculty adviser to its local chapter at the University of Wisconsin.

With all the notable array of accomplishments to his credit, Professor Duffee's zeal to reach higher and still higher goals of achievement continues with characteristic vigor. As one of his former students puts it, "His enthusiasm for new mechanical things is undiminished with the passing years. In fact, he keeps himself sharpened and out ahead of most engineers by having a drawing table handy in the recreation room at his home. He develops and prepares plans covering new ideas for machines and other equipment, and in this way he keeps mentally alert to present and potential needs of American agriculture."

In the opinion of this same former student, Professor Duffee's most outstanding attribute is his keen interest in developing young men. His greatest satisfaction seems to come from having the opportunity to bring out and develop the good qualities of the many young men attending his classes each year, and in seeing them achieve success later in their chosen profession. He delights too in seeing that younger staff members in his department are given the opportunity to prepare and obtain credit for papers they present at ASAE meetings or have published in farm or trade publications.

Of the many notable attributes possessed by this McCormick medalist, none is more generally known and appreciated than his ability as a dramatic speaker. He enjoys talking to groups, whether engineers, farmers, or students. In his lectures to students it is said that he not only covers the subject matter of the course but also offers advice on many things in general. When returning from a trip, for example, he is wont to give the students an extensive report.

A graduate of the University's combined agricultural-engineering curriculum and one of his closest friends opines that the thing from which Professor Duffee derives greatest enjoyment is his visits with farmers, especially those who were at one time students in an agricultural short course which he has been teaching for almost forty years. This is confirmed by a former student in this course and also a close friend who comments as follows:

"His reputation is well known throughout the rank and file of the so-called dirt farmers of Wisconsin, of which I am one. One side of Duffee's personality, perhaps not so widely known outside of this state, is his great desire and ability to get on common ground with practical farmers whenever he meets them. He possesses a warmth of personality and charm that is rarely found in individuals whose training has been largely technical or scientific.

"He is equally gifted on the lecture platform. I have seen him hold an audience of farmers spellbound while he was forecasting the engineering advances in agriculture which he foresaw in the offing. He did it with an eloquence which one does not ordinarily associate with an agricultural engineering laboratory.

"I also recall how on one occasion he sat cross-legged on the lawn back of my farm home with a group of picnicking farm management association members, in similar positions, all around him. Floyd lit his pipe and said: 'Well, boys, let's talk about farming.' Thereupon ensued a fascinating two hours' discussion about the mechanics of farming, with Floyd asking as many of the questions as the 'boys.'

"This ability to adapt himself, in his contacts with people, to a variety of situations has been, I believe, one of his greatest assets. After all, what good is an idea or a message if you do not get it across?

"Duffee's combination of scientific ability, Hoosier sagacity, and Irish good humor have all contributed to his becoming one of the outstanding figures in our Wisconsin College of Agriculture, where everyone knows who Floyd Duffee is."

Indeed it may well be said that, for all the distinction that Professor Duffee has so well earned as teacher, researcher and engineer, at heart this man remains a farmer, a true son of the soil, and it is surmised that he derives as much satisfaction from this fact as from any aspect of his life's experience.

Floyd Duffee and his wife, the former Grace L. Rowntree, reside in a beautiful wooded residential section of the village of Shorewood, a suburb of Madison. In his early years, Floyd's principal hobbies were band and orchestra along with a limited amount of fishing and hunting. Now, according to his associates, his hobbies are more closely allied to home and family. He is exceedingly proud of his three daughters, Patricia Mary, Mary Jane, and Joan, and especially enjoys his six grandchildren, for whom he maintains an almost continuous program of building swings, doll houses, etc.

A particular Duffee hobby in winter is building and stocking feeders for birds, which his friends say he enjoys immensely, perhaps even the battle with rabbits and squirrels that usually accompanies birdfeeding. It seems his first thought was to shoot the squirrels with an air pistol, so with thoroughly official formality he procured a permit from the village board to shoot within the village limits. It developed, however, that his aim was none too good, so he replaced the pistol with a rifle, but when he was not around to use it, the squirrels outsmarted him and robbed the feeder. He then mounted the feeder on a pipe, but the squirrels crawled up the pipe. He next greased the pipe, and he swears that, as he watched a squirrel crawl up the pipe and immediately slide back down, it sat on the ground and made faces at him.

From the warmth with which he was commended as a candidate for the Cyrus Hall McCormick Medal, there is abundant evidence of the admiration and esteem, even approaching affection, wherein Floyd Duffee is held not only by his colleagues but also by practical farmers whose interests he has

(Continued on page 476)

. . . Medalists

Fred R. Jones

(Continued from page 459)

Professor Jones' career as a teacher and department head was conspicuous for the tremendous energy that he put into everything he did. His former associates marvel at his capacity to carry the work loads he never hestitated to assume and at his ability to continue to do so. One former student says he has always admired Mr. Jones for his philosophy expressed in six words: "There is no substitute for work." No responsibility that ever came his way seemed to daunt him, and his endurance in carrying out the tasks at hand appeared to be limitless.

Commenting, in lighter vein, on Mr. Jones' vast energy, one of his former associates says: "The younger generation never really saw Mr. Jones in his prime; in fact, the impact of his initial arrival in College Station was terrific. He had scarcely set foot on the Texas A&M campus when there was a sudden release of his pent-up determination for action and shortly the agricultural engineering building was blown to smithereens — and without making even a scratch on his shiny Model T coupe parked nearby. Most people still think it was a tornado that hit the structure, but folks in the department insist that it was simply Mr. Fred getting under way."

To Fred Jones life is real and life is earnest, and this fact helps to explain his genuine interest in and concern for others, including both students and fellow faculty members. While this interest was concerned, for the most part, with the everyday human welfare of others, it far from ignored their spiritual well-being. It seems that on the Texas A & M campus they have a religious emphasis week each year during the spring semester. Throughout that week all classes are dismissed for one hour each day, during which a special religious program is presented. Being an ardent Methodist, Mr. Jones, while he was head of the agricultural engineering department, deemed it specially important that members of his department staff, as well as students, attend these religious programs. In fact, it is said that he usually made a routine check of his building to make certain that all available staff members were included among the faithful.

But in his conscientious effort to apply persuasion where it seemed to be needed, he appears to have been at somewhat of a disadvantage. It is said that he has a characteristic walk, the sound of which associates soon learned to recognize even at some distance down the hall as he approached their offices. On one such occasion two members of the staff sharing an office heard the familiar step, obviously headed in their direction. One of them it seems had an excuse for not attending the religious service that day, but since the other did not, he stepped into the small coat closet in the room where he was scarcely able to pull the door shut after him. Professor Jones on arrival proceeded to question the first staffer in his usual thorough manner until he was able to guess pretty well as to the whereabouts of the "missing soul." And sure enough, when he opened the closet door, there the missing prof stood at attention with heels together, chest out, and stomach and chin in. At the religious emphasis program that followed, it is said this prof heard his second sermon for that day.

Former students of Professor Jones are warm in their praise of him as a man, as a teacher, and as a friend. They mention his keen interest in both the personal and academic well-being of students of all classes. He was never too busy to take the time to discuss in detail and privately any difficulties a student might be encountering either in his or other departments of the college. This interest reached its peak in the student's senior year in a special course devoted mainly to preparing the student to enter the world of business. One former student remembers in particular the emphasis he placed on the young graduate understanding the proper use of credit and the importance of establishing a good credit reputation.

But the interest of this man in his students did not cease with their graduation. One such graduate now in a responsible position with a federal agency in the state, puts it this way: "If I were to select one outstanding trait of Fred Jones, college professor and developer of young men, it would be his continuing keen interest in students following graduation. I do not recall ever talking with him when he did not ask how 'his boys' were getting along, often inquiring specially about many of them. He was always wanting to know also

(Continued on page 476)

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Roller guidance has been established by the Anti-Friction Bearing Manufacturers Association as a major rating factor for roller bearings. There is a direct relationship between this factor and the life and capacity of a cylindrical roller bearing under load.

Figure 1 illustrates the results of a loose fit between a roller and the guiding ribs of the raceway. Because of lack of guidance by the ribs, the roller is free to skew and skid under load. Such a condition invariably leads to early bearing failure.

To achieve close roller fit and proper roller guidance, Bower precision grinds each bearing race on specially designed centerless grinders. In this operation, Bower positions the integral raceway ribs *from the theoretical centerline of the bearing*. This method produces bearings with high dimensional accuracy and perfect symmetry.

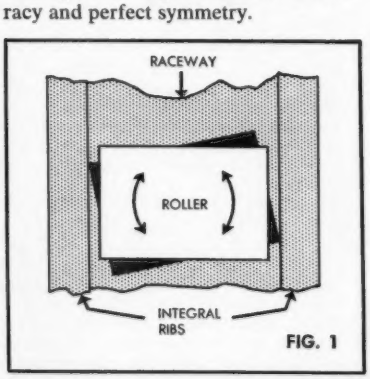
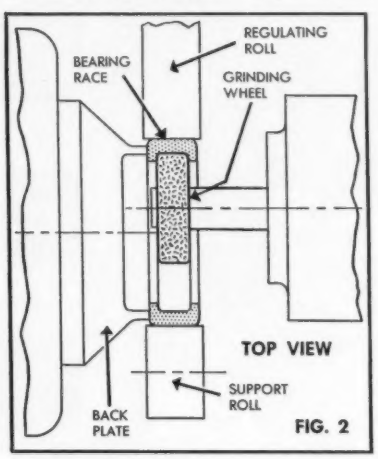
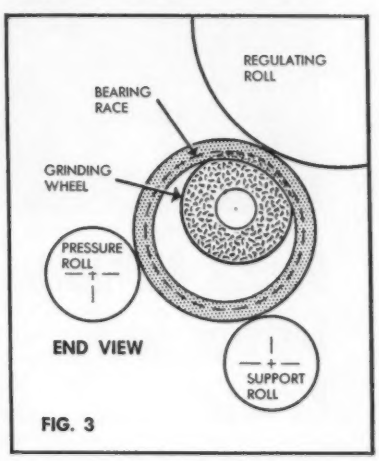


Fig. 1. Loose fit in raceway means poor roller guidance. Roller can skew and skid under load.

In addition, the close tolerances held in grinding the roller track and integral guiding ribs give Bower cylindrical roller bearings the ability to *take thrust in any direction*. A Bower cylindrical roller bearing has thrust capacity of from 10-15% of its rated radial capacity!



Figures 2 and 3 diagram the centerless grinding method used to finish Bower raceways. Use of this technique assures not only optimum roller guidance and maximum bearing life, but also virtually eliminates bearing runout. BEARING SYMMETRY WHICH RESULTS FROM THIS TECHNIQUE PERMITS ACCURATE SHAFT LOCATION REGARDLESS OF HOW THE OUTER RACE AND ROLLER ASSEMBLY ARE INSTALLED. IT COMPLETELY ELIMINATES THE POSSIBILITY OF IMPROPER INSTALLATION.



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North Atlantic Section

The North Atlantic Section will hold its annual meeting September 1-3 at the University of Maryland, College Park, Md. Activities will begin with a general session Tuesday morning, September 1, with opening remarks by F. L. Rimbach, director of rural development, New England Electric System, and section chairman. The speakers' theme will be "Agricultural Engineering in the Future of Agriculture, Education and Industry," and talks will be given by: A. O. Kuhn, executive vice-president, University of Maryland; L. H. Skromme, chief engineer, New Holland Machine Co. and ASAE national president; W. C. Libby, dean of agriculture, University of Maine; and J. L. Butt, ASAE executive secretary.

Also featured at a general session, scheduled for Wednesday afternoon, will be Col. John C. Lackas, U.S. Army, Industrial College of Armed Forces, whose subject will be "Role of Agriculture in Mutual Security;" a discussion of the agricultural engineering implications of Col. Lackas' address will follow by W. M. Carleton, assistant director, AERD, ARS, USDA, Beltsville, Md. Featured speaker at the banquet on Wednesday evening will be Charles B. Schuman, president, American Farm Bureau Federation. The topic of his address will be "Let's Fight Together for Agriculture."

The Tuesday afternoon program will consist of four concurrent sessions. The Farm Structures Division will have discussions on a herringbone milking parlor; poultry calorimeter studies on caged laying hens; measurement of solar heat energy to poultry buildings; economics of pork production; and farm buildings as part of this system. The Power and Machinery Division will hear about tillage at the crossroads; fertilizing forages; machinery and methods for establishing forage crops; and what's new in mowers. The topics to be covered by the Soil and Water Division will be: winterizing hydrologic research equipment; design on earth spillways; two-stage inlets; and small watershed program progress. The following subject will be discussed at the Electric Power and Processing session: Observation and discussion of electric power and processing research activities at agricultural engineering laboratory, Beltsville Research Center. Tuesday's sessions will conclude with a barbecue at Student Union Grove, weather permitting.

On Wednesday morning, September 2, three concurrent sessions are scheduled. At a joint meeting of the Farm Structures and Power and Machinery Divisions papers will be presented on field hay pelleters; recirculated air wagon drying; and performance characteristics of farm-type auger elevators; plus a panel discussion on random handling and drying of baled hay. Dairy water heater performance and low-starting current, single-phase motors will be discussed at the Electric Power and Processing Division session. At the Soil and Water session topics to be included are: Land smoothing for improved grassland farming; and land forming research in Virginia; plus a panel discussion on sprinkler irrigation for frost protection.

A tour of Beltsville Agricultural Research Center is planned for Thursday morning, and a meeting of those involved in farm buildings Plan Services in U.S. and Canada will be held Thursday afternoon.

A special program for ladies and children is scheduled during the three-day meeting, which will include a tour of Washington and vicinity and one of the home economics research facilities of Agricultural Research Center and the "Beltsville Kitchen."

Tennessee Section

The annual meeting of the Tennessee Section will be held October 9 and 10 at the University of Tennessee, Knoxville. Further details will be announced later.

North Carolina Section

The North Carolina Section will hold its Summer Meeting on August 23-25 at Camp Swannanoa, Swannanoa, N.C. Registration will begin Sunday at 2:00 p.m. A formal meeting is scheduled for Monday morning, with R. W. Wilson, chairman, presiding. The topics to be discussed are: The parks of North Carolina—what do they offer?; the significance of the food processing industry in North Carolina; the Gerber products and western North Carolina; and how to get the most out of your food dollar. On Monday afternoon there will be two conducted tours; one through the Champion Paper & Fiber Co., Canton plant; and the other through the National Weather Records Center, Ashe-

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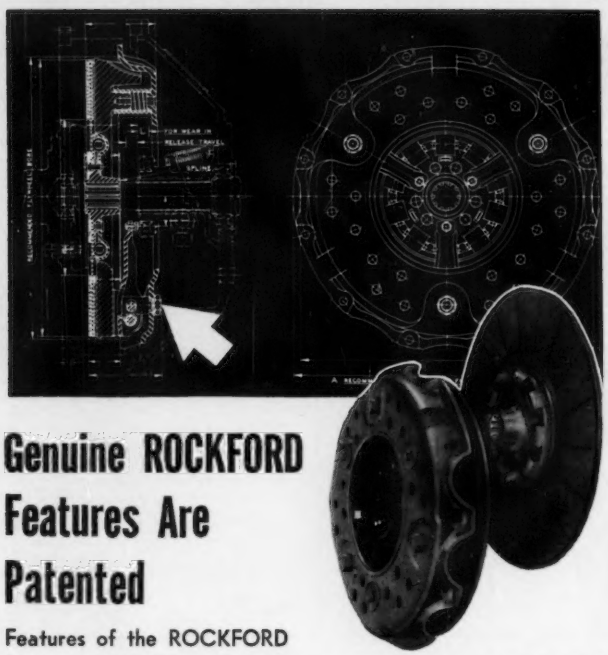

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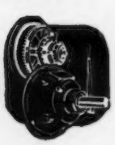
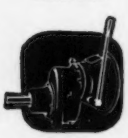

Power Take-Offs


Speed Reducers

SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

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CLUTCHES

ville. After the 6:00 p.m. dinner, a business meeting will be held.

The Tuesday morning activities will include a tour through the Biltmore Estate, including house, gardens, and dairy farm. The meeting will conclude Tuesday noon with luncheon at Camp Swannanoa.

Those attending will have an opportunity to view the pageant "Unto These Hills," on Sunday evening at 8:00 p.m. Swimming (a pool is in the area), softball, volleyball, horseshoe pitching, basketball and hiking can be enjoyed. Camp recreation and handicraft instructors will be on hand to help with activities. Also of interest, would be a visit to a nearby abandoned mica mine.

New officers for the North Carolina Section have been reported as follows: Chairman, R. W. Wilson; first vice-chairman, Jan van Schilfgaarde; second vice-chairman, E. J. Tyson; secretary-treasurer, W. H. Johnson, and Nominating Committee, W. E. Splinter, J. N. Howard and H. W. Ellis.

The Executive Committee looks to a year of progress with the following newly appointed committees: Professional Information, J. M. Fore (chairman), E. S. Coates, J. M. Howard, G. Y. Greene and Henry Bowen. Membership, W. T. Mills (chairman), S. C. English, J. P. Goff, J. I. Sewell. Publication, Eustace Beasley (chairman), W. H. Henson, E. L. Howell and J. D. Traywick. Student Scholarship, J. F. Kelly (chairman), G. W. Giles and F. J. Hassler. Motion Picture, H. M. Ellis (chairman), J. P. Dail and J. W. Dickens. Arrangements, R. M. Ritchie.

Ohio Section

The Fall meeting of the Ohio Section is to held on Monday, October 12, at the Agricultural Experiment Station, Wooster, Ohio. This is a departure from the Fall meetings usually held on the Ohio State Campus, but it was felt desirable to hold the meeting at the time of the dedication of the new Agricultural Engineering Building at the Wooster Station. The dedication is to take place at 10:30 a.m. L. H. Skromme, ASAE national president, will be on hand for the dedication and also will speak at the noon luncheon. This is to be followed by a full program in the afternoon, which will relate to items of interest to members of the National Duster and Sprayer Association. Their meeting will be held the following day. A block of tickets for the Illinois-Ohio State football game on the previous Saturday, October 10, has been reserved as usual.

Minnesota Section

The Minnesota Section held an afternoon and evening meeting on May 7. Papers presented during the day covered all phases of agricultural engineering work. W. A. Junnila of Agricultural Research Service, USDA, discussed the engineering aspects of modern day egg and broiler factories, drawing upon his many contacts with the broiler industry in New England. P. W. Manson of the agricultural engineering department, University of Minnesota, gave a review of agricultural water facts, emphasizing the many misconceptions the public has in this field. D. E. Brail of Molded Fiber Glass Body Co. reported on fiber glass reinforced plastics as replacement for sheet metal parts and assemblies. Following that, in his talk on designing machinery for a dynamic agriculture, R. R. Raney, director of engineering, New Idea Co., discussed the changes which are taking place in the design criteria for farm machinery. *(Continued on page 476)*

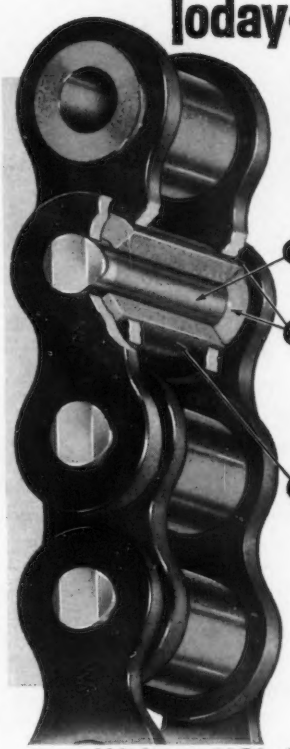
PROGRESS IN POWER TRANSMISSION CHAIN DESIGN

In 1953...

Whitney introduced the first oil-impregnated, sintered steel bushing roller chain — a major advance in chain design.

Not content with leading the field with the first sintered bushing chain, Whitney Engineers continued their exhaustive field research... carried on searching studies of the original sintered bushing chain in an effort to produce an even better chain with optimum performance characteristics. Their work, coupled with recent developments in sintering technology, resulted in the development of MSL Chain—a completely new concept in power transmission chain.

Today...



WHITNEY MSL* CHAIN . . . a product of continuing Whitney Research—is another giant step forward in chain technology because it advances and improves on the basic idea of oil-impregnated, sintered steel bushings in power transmission chain.

Only Whitney MSL Chain with oil-impregnated bushings assures complete built-in lubrication at all three critical lubrication areas:

1. **Pin**—Protective film of oil completely lubricates the live bearing area between pin and bushing, minimizing wear by reducing metal-to-metal contact.
2. **Plates**—Whitney oil-impregnated sintered steel bushings extend beyond surface of inside plates to act as lubricated thrust bearings, control clearance, and provide an oil cushion between plates, eliminating plate galling and seizing frequently caused by misalignment of sprockets.
3. **Sprocket Engagement**—MSL Chain does not require rollers, as the tough oil film on the bushing surface provides smooth sprocket engagement, cushions impact and reduces drive wear.

Inherent material characteristics of Whitney sintered steel bushings, plus bushing configuration that provides greater contact area between bushings and links, permit high interference fit, which pre-loads links and gives maximum fatigue resistance.

Whitney MSL Chain meets ASA Standards

It is made in Standard and Extended Pitch types, and is completely interchangeable with any similar pitch ASA Standard chain. For full details, write for MSL Catalog G1-59, or call your nearby Whitney Chain Distributor, who carries MSL Chain in stock for quick delivery.

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PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listings.

Positions Open – February – O-13-901. **March** O-39-904, 41-905, 45-906, 45-907. **April** – O-50-908, 55-909, 58-910, 56-911, 59-912, 71-913. **May** – O-77-914, 49-915, 95-917, 66-918, 97-919. **June** – O-124-920, 131-922, 132-923, 111-924, 133-925, 135-926, 136-927, 137-928, 149-929, 140-930. **July** – O-170-931, 177-932, 186-933.

Positions Wanted – January – W-355-67, 383-68, 411-69, 412-70, 406-71, 419-72, 422-73. **February** – W-9-1, 17-2, 22-3, 23-4, 20-5. **March** – W-25-6, 33-9, 30-10. **April** – W-54-11, 70-12, 72-13. **May** – W-83-15, 84-16, 80-19, 98-20, 99-21, 100-22, 102-24. **June** – W-103-25, 104-26, 118-27, 112-28, 123-29. **July** – W-154-31, 178-32, 196-33, 190-34.

NEW POSITIONS OPEN

Agricultural Engineers (2) for teaching and graduate study, each one-half time, any subject matter area, at a northeastern state university. BSAE or equivalent, with grades acceptable for admission as a graduate student. Usual personal qualifications for teaching and graduate study. Up to 30 credits per year on graduate program. Open for beginning of 1959-60 school year. Salary $2535 plus tuition and fees. O-214-935

Salesman for pneumatic conveyor and equipment for grain storage in Kansas, Nebraska, and Colorado, for established company. Choice of location in area. Age 25-45. BSAE preferred. Sales experience and knowledge of grain and feed handling practice. Executive appearance and approach. Opportunity up to individual. Pay on straight commission basis. Salesmen in this territory have made up to $1,000 monthly. More possible. O-215-936

District Sales Manager for established eastern wholesaler of agricultural and light industrial equipment. Territory in western Pennsylvania, near Altoona. Prefer married man, age 25-45, with agricultural engineering training and wholesale sales experience in agricultural field. Travel in limited area, away from home one or two nights per week. Position is in line of advancement to higher management. Salary and expenses plus 5% commission. O-216-937

Agricultural Engineer for testing and research work of tractors, engines and component parts for a Midwest tractor and implement company. Must have sound basic engineering training, thorough understanding of mechanics and strength of materials. Must be acquainted with tractors, engines and transmission procedures. Degree in agricultural or mechanical engineering. Salary open. O-217-938

Project Engineers (2) for established manufacturer of farm and industrial materials handling equipment. One for development of commercial grain and seed processing equipment. One for development of air conveying equipment. Location upper Midwest. Age 25-35. BS or MS in agricultural or mechanical engineering. Experience 3 years in similar work. MS considered in lieu of experience. Need creative self-starter, articulate, and able to work well with production, sales, management, and customer groups. Excellent opportunity with growing company. Salary open. O-218-939

Agricultural Engineer capable of designing, improving and testing a complete line of hog feeders, fountains and automatic equipment. Knowledge of sheet metal work. Age open. Prefer college graduate with farm background. Able to meet and work with people. Salary open. O-212-940.

Senior Project Engineer for design, development, and testing of harvesting equipment with established manufacturer in Midwest. Age under 40. BSAE, BSME, or equivalent. Experience 4 to 6 years in farm implement design, preferably on harvesting equipment. Opportunity based on proven qualifications and job performance. Salary open. O-220-941

Design Engineer for work on agricultural earth-moving equipment from concept of new products through layout, experimental models, field trials, and design for production, with established western manufacturer. Age 30-40. BSAE or BSME. Specialized experience in design of agricultural earth-moving equipment. Usual personal qualifications for commercial design engineering. No administrative duties. Secure future for right man. Salary open. O-223-942

Project Engineers (3) for design and development of farm equipment, tractors, and hydraulics, with established manufacturer in Upper Midwest. BSAE. Experience 8-10 years in field. Must have initiative, accept responsibility, and be able to work with others. Opportunity according to ability. Salary open. O-228-943

Design Engineers (3) for design of farm equipment, tractors, and track-type tractors, with established manufacturer in Upper Midwest. BSAE. Experience 4-5 years in field. Must have initiative, accept responsibility, and be able to work with others. Opportunity according to ability. Salary open. O-228-944

Product Development Engineer for work on crop drying and ventilating equipment with established manufacturer. North Central location. BSAE or equivalent. Experience 4-5 years farm equipment design and development. Usual personal qualifications for commercial development engineering. Good working conditions. Excellent opportunity for advancement. Salary open. O-227-945

Chassis Engineer for design and development of tractor chassis and related components with large manufacturer. Midwest location. Age 25-45. BS in agricultural or mechanical engineering. Experience 3 years chassis design on tractors, trucks, or cars. Will also consider recent graduate. High degree of aggressiveness, ingenuity and analytical ability. Opportunity for advancement to senior engineering and supervisory responsibilities. Attractive starting salary and fringe benefits. O-231-946

Research Engineer (hydraulic equipment) to handle determination of hydraulic design approaches, evaluate hydraulic design alternatives, perform laboratory and field tests, handle related duties and responsibilities. Large manufacturer. Midwest location. Age 22-35. BSAE, or BSME and farm background. Experience in design and development of hydraulic components desirable. Will also consider outstanding recent graduate. Must have high degree of native intelligence and analytical ability together with perseverance in overcoming hydraulic problems. Opportunity for high-level nonsupervisory and senior research engineering positions. Attractive starting salary and fringe benefits. O-231-947

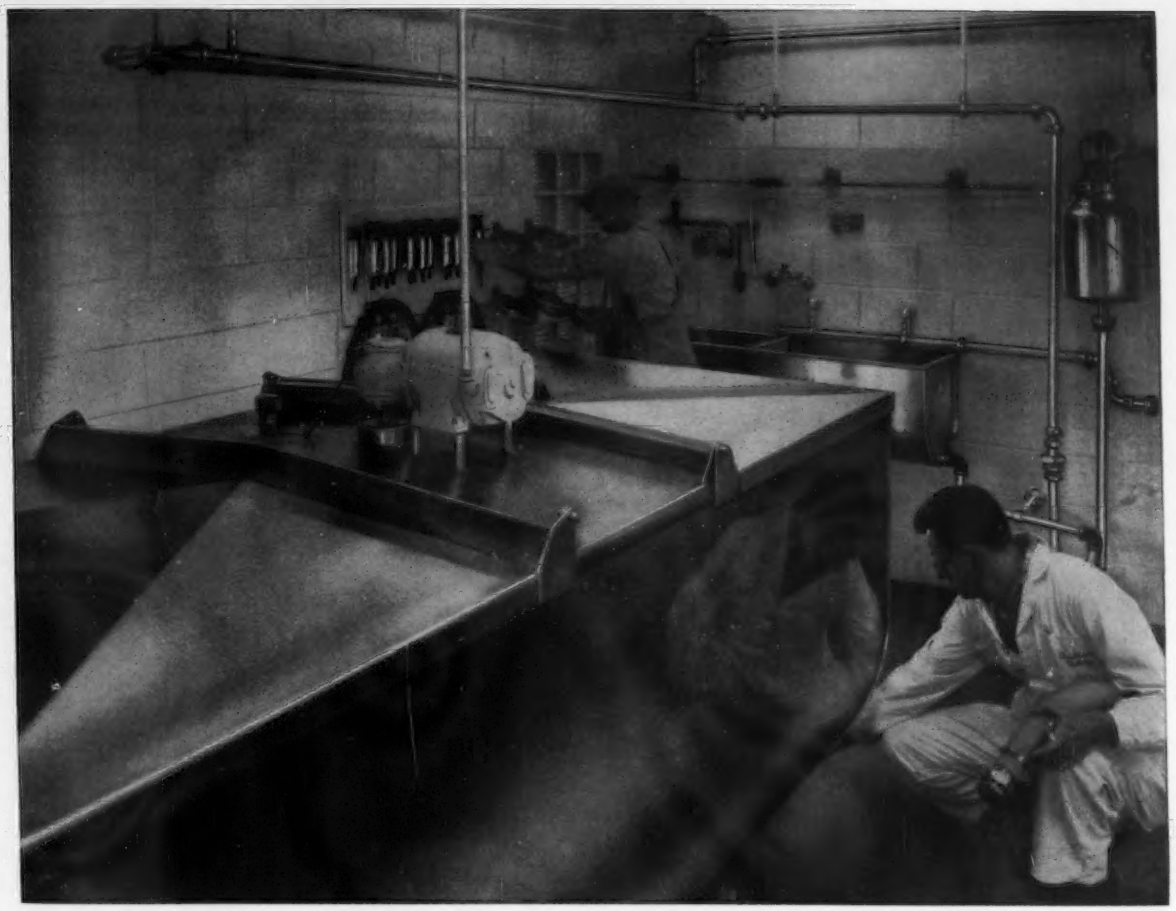
Research Engineer (machinery design), farm equipment field with large manufacturer in Midwest. Select functional approaches, investigate basic designs, design machines, supervise building of experimental units, and make modifications. Age 28-40. BSAE, or BSME with farm background. Experience 5 years in mechanical design and development, preferably in farm equipment. Will also consider outstanding individuals with less experience. Should have farm background and be thoroughly familiar with agricultural production problems. High in aggressiveness and ingenuity. Capable of advancement to senior research engineer and supervisor. Attractive starting salary and fringe benefits. O-231-948

Project Engineer for design, development and test work on dairy farm equipment with established manufacturer in Midwest. Age 21-35. BS degree in agricultural, mechanical, or dairy engineering. Dairy farm background, design and development experience in dairy farm or plant experience desirable. Some design experience essential. Want ambitious man who can work with others; and has ability and desire to develop ideas into finished products. Excellent opportunity in expanding engineering department of fast moving company. Position open effective September 1. Salary open. O-247-949

Project Engineer with specialized design experience to head up a group with responsibility for backhoe and loader design and development with large, progressive organization. Location Illinois, suburban Chicago area. Age under 45. Degree in agricultural or mechanical engineering with emphasis on mechanical design and development. Three (3) years minimum experience on backhoe, loader and related tractor-mounted equipment. Creative experience, initiative and willingness to accept responsibility are required to carry designs to their successful conclusion. Excellent working conditions with supporting facilities to aid in design and development. Salary open, commensurate with experience and ability. O-259-950

Design Engineer with some backhoe, loader and related tractor mounted equipment experience for work with large progressive organization. Location Illinois, suburban Chicago area. Age under 35. Degree in agricultural or mechanical engineering with emphasis on mechanical design and development. Excellent working conditions with supporting facilities to aid in design and development. Salary commensurate with ability and experience. O-259-951

(Continued on page 476)



Stainless steel proved best for handling milk in bulk

Ever since the first dairymaid slipped and fell headlong into the pool of spilled milk, dairymen have tried to devise better ways of handling milk. They found improvements, but a lot of spilled milk was cried over before they found that the real answer was to handle milk in bulk . . . with Stainless Steel.

In 1949, there were fewer than 2,000 bulk milk tanks in use . . . and those mainly in California. Then United States Steel cooperated with the University of Wisconsin and equipment fabricators in developing accepted methods for handling milk in bulk—and equipment to do the job. U. S. Steel helped to point out the advantages of this new system to dairy farmers throughout the country.

As a result, there are now over 125,000 bulk milk tanks in use that handle over one half of the milk produced for fluid consumption. If you would like information on bulk milk handling, write to United States Steel, Agricultural Extension, 525 William Penn Place, Pittsburgh 30, Pa. *USS is a registered trademark*

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NAME_____

ADDRESS_____

CITY & STATE_____

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Bason, George S., Jr.—With the armed forces (Mail) Swepsonville, N. C.

Bonner, M. G.—Dist. rural engr., Alabama Power Co., Selma, Ala.

Chapman, Walter E., Jr.—Cotton technologist, Southwestern Cotton Ginning Res. Laboratory, USDA. (Mail) 2225 Hixon Dr., Las Cruces, N. M.

Cook, Harry S.—Agr. engr., (SCS) USDA. (Mail) Mtd. R. 2, W. Ct. and Rd. 68, Pasco, Wash.

DeGiorgis, Marcello A. — Consulting engr., Pirelli S.p.A., 11 W. 42nd St., New York, N. Y.

Dobson, H. E.—Washington mgr., Food Machinery and Chemical Corp., 539 Wyatt Bldg., 777 14th St., N.W., Washington 5, D. C.

Field, Roddy H.—Sales engr., General Metals Inc. (Mail) R.R. 4, Box 179, Greensboro, N. C.

Held, Robert B.—Experimental engr., Allis-Chalmers Mfg. Co., Box 518, Independence, Mo.

Hu, Wan-Wang—Graduate student, div. of irrigation, agr. eng. dept., Farm Campus, University of Minnesota, St. Paul 1, Minn.

Hunt, Ralph E.—Asst. gen. mgr., Tractor and Implement Div., Ford Motor Co., 2500 E. Maple Rd., Birmingham, Mich.

Jenkins, Howard L. — (self-employed) P.O. Box 5, Spokane 10, Wash.

Kraus, John H.—Irrigation engr., irrigation div., The Jewish Agency. (Mail) 88 Jerusalem St., Ramat-Itzhak, Ramat Gan, Israel

Leach, Arthur D.—Assoc. in charge of field operations, Rockefeller Foundation. (Mail) Casilla 13045, Santiago, Chile, South America

Manley, Philip L.—Agr. engr., (ARS), USDA. (Mail) 620 Hudson St., Ithaca, N. Y.

McCune, William E.—Prof., agr. eng. dept., A. & M. College of Texas, College Station, Tex.

Padhi, Jaya D.—Student. (Mail) 1207 Paquin St., Columbia, Mo.

Pandya, Shirish S.—Agr. engr., Pandya Farms, Dohad (W. Rly.) Bombay State, India

Powell, Billy W. — Field rep., Boeing Airplane Co. (Mail) 2808 South 146th St., Saettle 88, Wash.

Raunikar, Fred., Jr.—Gen. foreman, Ralston Purina Co. (Mail) 2951 S. Fern, Wichita 13, Kans.

Roth, George A. — Maint. mgr., Murrayair Ltd., Honolulu International Airport, Honolulu, 1 Hawaii

Savadamuthu, S.—Asst. agr. engr., Soil Conservation Scheme, Panruti, Madras, India

Schwartz, Clayton J. — Midwest advertising mgr., Electricity on the Farm Magazine, Suite 1210, 59 E. Van Buren St., Chicago 5, Ill.

Skromme, Austin G., Jr.—Asst. chief engr., Caterpillar Tractor Co., Ltd., Tannochside nr. Uddingston, Lanarkshire, Scotland

Smith, Ralph — Acting area engr., (SCS) USDA. (Mail) P.O. Box 703, Ely, Nev.

Styliades, George C. — Graduate student. (Mail) 181 Winbourne Rd., Rochester, N. Y.

Treaby, Bruce W. J.—Soil conservator, Soil Conservation Service, Dept. of Agr., Palmerston North, New Zealand

TRANSFER OF MEMBERSHIP

Beckett, F. E. — Assoc. prof. of agr. eng., Louisiana Polytechnic Institute. (Mail) 1313 Cooktown Rd., Ruston, La. (Associate Member to Member)

Maley, Wayne A.—Field engr., American Zinc Institute. (Mail) 735 Owen St., Lafayette, Ind. (Associate Member to Member)

Saul, Robert A. — Agr. engr., (AERD) (ARS), USDA, 213 Agr. Eng. Bldg., ISC, Ames, Iowa (Associate Member to Member)

Schepers, P. R.—Gen. farm service supervisor, Consumers Power Co., 212 W. Michigan Ave., Jackson, Mich. (Affiliate to Member)

Wiersma, J. L. — Prof. of agr. eng., South Dakota State College, Brookings, S. D. (Associate Member to Member)

STUDENT MEMBER TRANSFERS

Alger, Thomas M. — (Cornell University) (Mail) c/o Fromm Bros., Inc., Hamburg, Wis.

Barnard, Everett B.—(University of Maine) (Mail) Shawmut, Maine

Beard, Eldon R.—(Oklahoma State University) (Mail) Flood Prevention Office, (SCS) USDA, R.R. 1, Chickasha, Okla.

Blagrave, Derwood C. — (Texas Technological College) (Mail) Big Spring, Texas

Block, Donald P. — (Rutgers University) (Mail) 284 N. 13th Pl., Prospect Park, N. J.

Brooks, Bradford — (University of Maine) (Mail) 85 N. Union Height, Manchester, N. H.

Brooks, Royce G.—(Texas Technological College) (Mail) 5415 22nd St., Lubbock, Tex.

Brown, Ted—(Texas Technological College) (Mail) c/o Andrew W. Brown, Dublin, Tex.

Crowder, William A.—(Clemson Agricultural College) (Mail) Box 126, Lattimore, N. C.

Dorminey, Osborne—(University of Georgia) (Mail) R.R. 2, Douglas, Ga.

Ewing, Carrel — (University of Missouri) (Mail) Warsaw, Ill.

Finch, Edwin O.—(North Carolina State College) (Mail) R.R. 1, Bailey, N. C.

Floyd, Renworth R.—(University of Maine) (Mail) Ellsworth, Maine

Gehman, Roland P.—(Pennsylvania State University) (Mail) R.R. 1, Bareville, Pa.

Gilliam, Harry L. — (Clemson Agricultural College) (Mail) 109 Summit Ave., Brevard, N. C.

Hatcher, Glen C. — (North Carolina State College) (Mail) R.R. 2, Selma, N. C.

Hutton, Gale A. — (Clemson Agricultural College) (Mail) Lloyd St. at Super Highway, Greer, S. C.

Johnson, Lyle M. — (Cornell University) (Mail) P.O. Box 325, Williamson, N. Y.

Kaisner, John U.—(Texas Technological College) (Mail) 2815 30th St., Lubbock, Tex.

Medders, Harlan J.—(University of Georgia) (Mail) R.R. 2, Sylvester, Ga.

Mickley, John W., Jr. —(Pennsylvania State University) (Mail) R.R. 2, Gettysburg, Pa.

Mills, William C. — (Clemson Agricultural College) (Mail) R.R. 1, Blackstock, S. C.

Moore, Stephen F.—(University of Vermont) (Mail) East Peacham, Vt.

Mosher, Henry L.—(University of Maine) (Mail) 287 Main St., Orono, Maine

Murray, Calvin E.—(University of Georgia) (Mail) R.R. 1, Screven, Ga.

(Continued on page 476)

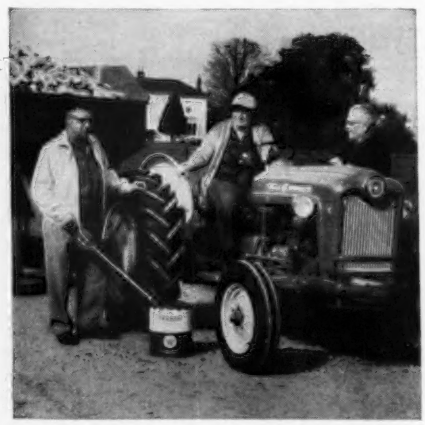
HOME-MADE LOADER SAVES TIME AND TOIL!

Max Johnson farms 700 acres near Mesilla Park, New Mexico. Here is shown the home-made loader he built in his spare time. A small gasoline engine powers the conveyor belt.

Mr. Johnson has found that his portable loader is both a time and money saver, in addition to eliminating much hard manual labor. He finds many uses for it in loading, transporting and storing feed and other farm products.

Shown at left is B. H. Melton of the J. B. Ritter Distributing Co., who supplies Mr. Johnson with quality Texaco products. Both know that *it pays to farm with Texaco products.*

OUR FIRST CENTURY BORN IN FREEDOM WORKING FOR PROGRESS



17 years with Texaco!

"Marfak is the best lubricant I've ever used," says George Gunlock (left), who farms 800 acres near Chillicothe, Ohio. With him are Dorothy George, wife of a tenant, and W. A. River, River Bros. Oil Co. Mr. Gunlock prefers Marfak because it won't drip out, wash out, dry out or cake up. It forms a collar around open bearings, sealing out dirt and grit. A Texaco customer for 17 years, he also likes Mr. River's dependable, neighborly service. He, too, agrees that it *pays to farm with Texaco products.*

BUY THE BEST...BUY TEXACO

. . . Personnel Service

(Continued from page 472)

CIVIL SERVICE NOTE

Agricultural Engineers are included in a list of 20 fields of engineering and related work in which the United States Navy has current openings, for assignment in the Pacific area. Grades are GS 5 through 12. Usual federal Civil Service regulations apply. These openings are covered by Announcement number 12-95-1 (5a), issued 30 June 1959, and are open indefinitely. Application on Standard Form 57 and card Form 5001-ABC should be filed with Navy Board of United States Civil Service Examiners for Pacific Overseas Employment, 45 Hyde Street, San Francisco 2, California.

NEW POSITIONS WANTED

Agricultural Engineer for design, development or research in power and machinery or farm structures with manufacturer or consultant. Any location. Limited travel. Married. Age 26. No disability. BSAE, 1958, Iowa State University. Farm background. One summer with USDA as aid in research on grain drying and pressure studies on grain storage structures. One year with Illinois Division of Highways on design and construction. Enlisted service in Army, 2 years. Available on reasonable notice. Salary $6,000. W-199-35

Farm Mechanics Specialist for sales, service or writing in electric power and processing or materials handling field with manufacturer, distributor, processor, or farming operation. Any location. Will travel. Married. Age 28. No disability. BSA, major in farm mechanics, 1952, Ohio State University. Farm background. Owned and operated custom hay baler during summer vacations while in college. Farm sales work for power supplier, 1952-57. Promoted in 1957 to farm service advisor in charge of all farm sales, sales promotion, research, and testing of newly developed farm equipment for the company. Available on 60 days notice. Salary $7,200. W-210 36

Agricultural Engineer for development, extension, teaching, research or sales in power and machinery or soil and water field with industry or public service in Southwest. Married. Age 38. No disability. BS, 1953, Louisiana Polytechnic Institute. Some graduate work at Louisiana State University. Farm background. Soil Conservation Service 12 years. Research and teaching 2 years. Sales engineer 2 years. War service in Infantry nearly 2 years. Available on reasonable notice. Salary open. W-224-37

Agricultural Engineer for design, development, or research in power and machinery or soil and water field, with manufacturer or federal agency, preferably in Wisconsin or Minnesota. Married. Age 25. No disability. BSA and BSME, 1957-58, University of Wisconsin. Farm background. Farm and light construction work during summer vacations. Part-time aide 2 years to soil scientist on USDA, Agricultural Research Service projects in soil and water field. Since graduation, design engineer, Missile Division, McDonnell Aircraft Corporation. Available on reasonable notice. Salary open. W-213-38

. . . Medalists
Fred R. Jones

(Continued from page 468)

how his department could improve the preparation of graduates. I attribute the fact that our agency has so many outstanding young men from his department to his excellent leadership and to the fine example he set for his graduates."

The great admiration and esteem in which Fred Jones is held by his former students and associates at Texas A & M College are apparent in the warmth of their individual estimates of him as a leader, as an administrator, as a teacher, and as a friend. This and the high esteem in which he is held by agricultural engineers generally combine to bear abundant evidence of this agricultural engineer's sterling qualities and the notable service he has performed in his profession. His selection as the recipient of the John Deere Medal for 1959 will be widely acclaimed by all who know him and especially by former students and professional colleagues who have had the privilege of being at one time associated with him.

. . . Medalists
Floyd W. Duffee

(Continued from page 467)

so faithfully served not only in Wisconsin but far beyond its borders. Here is an agricultural engineer, nationally known and highly respected, who claims no academic degree in engineering, but who by sheer strength of character, native ability, and boundless energy has forged his way to the top ranks of his chosen profession. It is simply his unflagging devotion to accomplishing the work that was given him to do that has so well earned him the honor conferred upon him by the award of the Cyrus Hall McCormick Medal.

. . . With ASAE Sections

(Continued from page 471)

A social hour and banquet followed. The speaker in the evening was Professor S. A. Engene of the agricultural economics department, University of Minnesota. Dr. Engene spoke on the changes in Asia which he had observed in his recent work in Japan, Korea and India. Following the evening speaker, the officers for the coming year were introduced. They are: Chairman, Andrew Hustrulid; first vice-chairman, Arnold Flikke; second vice-chairman, M. L. Gustafson; third vice-chairman, Darrell Walker, secretary-treasurer, Evan Allred; editor, Jesse Pomroy; director, Minnesota Federation of Engineering Societies, A. E. Kvamme; and alternate director, D. W. Bates.

. . . Membership Applicants

(Continued from page 474)

Northcut, Beade O.—(Texas Technological College) (Mail) Box 95, Pecos, Tex.
Odden, Norman T. — (Cornell University) (Mail) 827 Longwood Dr., Haddonfield, N. J.
Pellerin, Roger — (University of Maine) (Mail) R.R. 1, Fairfield, Maine
Royster, Robert L.—(North Carolina State College) (Mail) Buffalo Junction, Va.
Ruth, Cornelius W., III—(Texas Technological College) (Mail) LaFeria, Tex.
Sailors, Jimmy R.—(University of Georgia) (Mail) Jefferson, Ga.
Sievert, Richard E. — (South Dakota State College) (Mail) 711 14th Ave., Brookings, S. D.
Strickland, Lex W.—(University of Georgia) (Mail) R.R. 2, Claxton, Ga.
Todd, Ernest V.—(University of Georgia) (Mail) R.R. 3, Toccoa, Ga.
Toro, Pablo — (Cornell University) (Mail) Air Mail Box 43-37, Bogota, Colombia, South America
Turner, Robert G.—(University of Vermont) (Mail) 15782 Indiana, Detroit, Mich.
Turner, William J.—(University of Georgia) (Mail) R.R. 5, Blakely, Ga.
Uhl, James B.—(Pennsylvania State University) (Mail) Newfoundland, Pa.
Williamson, Robert E. — (Clemson Agricultural College) (Mail) c/o Mrs. J. D. Howell, R.R. 3, York, S. C.
Wright, Farrin S. — (Clemson Agricultural College) (Mail) NBA 15, Clemson, S. C.

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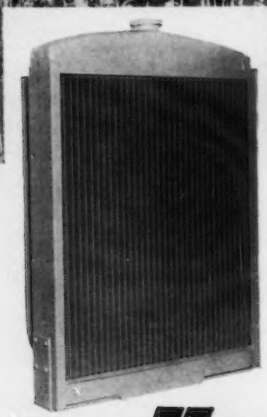

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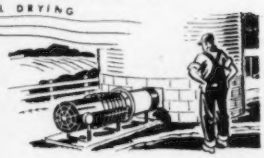

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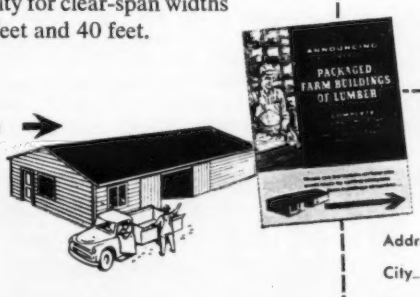

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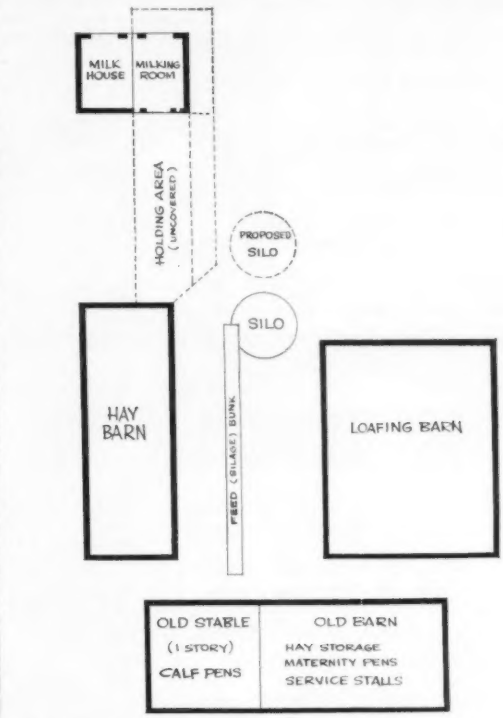

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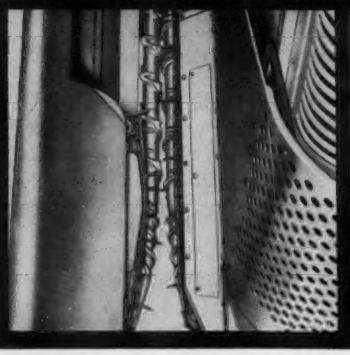

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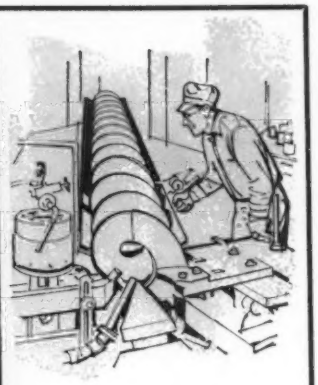

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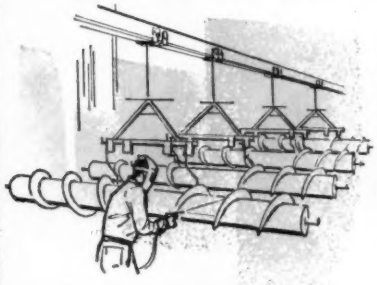

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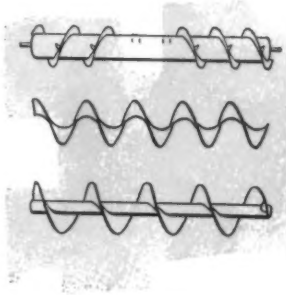

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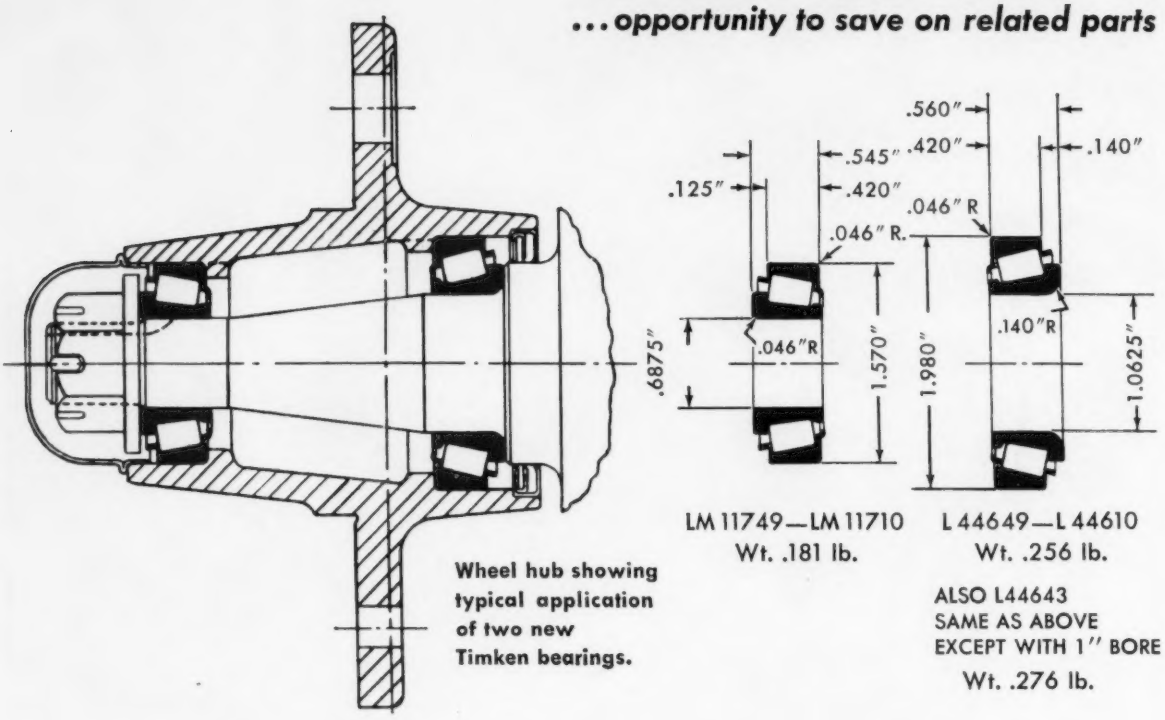

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